Lamb Island Dairy Remediation
30% Design Package
SFWMD Contract No. C-13410

Prepared for:

South Florida Water Management District
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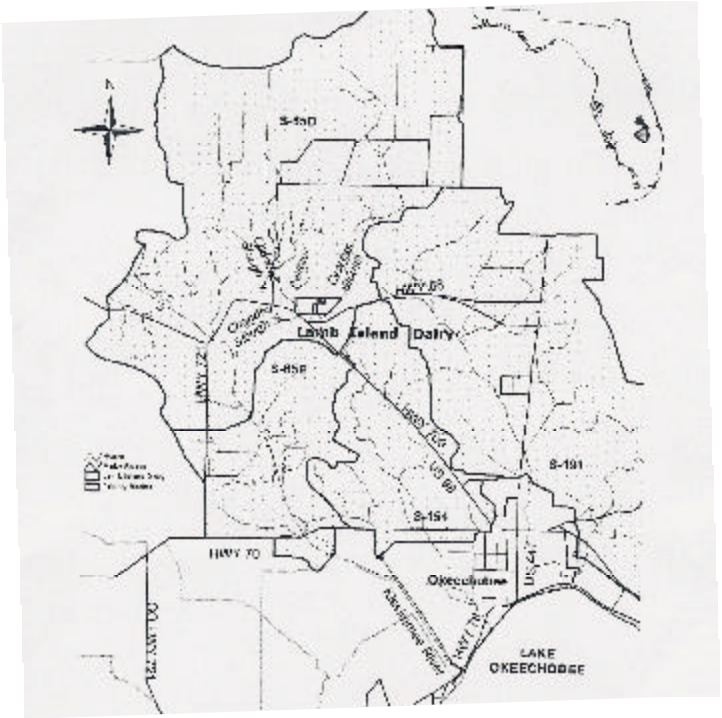
West Palm Beach, Florida 33406



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EXECUTIVE SUMMARY

The former Lamb Island Dairy Farm, approximately 808 acres in size, was abandoned 6 years ago and is currently owned by the District. In 2000, Dames & Moore (D&M) conducted a waste management assessment on the Dairy including characterization of the serial waste storage ponds, high intensity areas (HIAs), eco-reactor and irrigation ditches as part of a closure plan. The primary phosphorus (P) sources were identified as barn wash water, cow spray and runoff from HIAs and perimeter dike. The D&M report includes a description of the Bion wastewater treatment system that was installed at the dairy. The Bion system included treatment of wastewater and runoff from the HIAs and perimeter ditch which were serially pumped to a 1-acre 1st stage primary settling pond, a 2-acre anaerobic/facultative pond, a 5-acre anaerobic/facultative pond and then to an eco-reactor system that provided final chemical and biological treatment. The 1st pond received the high concentration wastewater solids from the milking parlor complex (barn wash, cow spray, runoff from the HIAs and from the perimeter ditch around the HIAs). The final eco-reactor pond is comprised of a shallow waste storage area where iron salts were added to precipitate out P. Grass in the pond with P accumulation was harvested periodically and was used for cow feed. Excess flow into the pond was used for land application by spray irrigation.

HSA Engineers & Scientists (HSA) was retained by the South Florida Water Management District (District) to develop and implement one or more remedial alternatives with the primary objective of minimizing P discharges from the Site. Preferred remedial measures would minimize offsite P runoff while being cost effective with respect to both capital and long term operation and maintenance expenditures. A review of the most recent soils and water site phosphorus data obtained from the property along with a listing of preliminary remedial recommendations were provided in the Agricultural Nutrient Management Assessment (AgNMA) (SWET, 2002) . Soil and water phosphorus data contained in the AgNMA were used by HSA to develop recommended remedial measures.

HSA with technical support from sub-consultants, Engineering and Applied Sciences (EAS) and Wetland Solutions, Inc. (WSI), prepared a draft 30% complete remedial nutrient removal design for the Lamb Island Dairy. After submittal of this package, HSA was requested to provide additional information on remedial alternatives to be potentially used on the site to ensure the most cost effective nutrient removal approach that would minimize long-term O&M. This Final Preliminary (30%) Design Package incorporates these changes and other changes discussed above as responses to the Interagency Team's comments.

The Phase I remedial design includes:

- Constructing a surface water containment berm around the HIAs and high P soils, gravity flow of storm water runoff to the existing eco-reactor and swale for biological (wetland) treatment;

- Constructing a shallow terracing berm at the edge of farm to collect and store runoff;
- Chemically treating settling pond and cooling pond water;
- Chemically amending the waste (residual manure solids) material from Pond 1 and 2 and leaving the material in-place;
- Backfilling the perimeter ditch; and,
- Hay cropping of all available land areas.

Other residual manure waste management alternatives including *in-situ* bioremediation are being investigated. Any proposed changes to the manure waste management alternative will be discussed with the District Project Manager. Alternative waste management alternatives will be presented, if necessary, in subsequent design documents for comment by the Interagency team.

The treatment system performance will be monitored and the results will be compared with future regulatory requirements. If the load reduction is not sufficient further treatment will be proposed (Phase II). Phase II alternatives include more active treatment scenarios including pumping to return gravity drained storm water runoff to the wetland treatment system and edge of farm treatment systems.

Total phosphorus content of storm water runoff from the area west of Lamb Island Road has averaged 0.194 mg/l as P during recent years. Due to the low concentration of P in the soils, the area west of Lamb Island Road is not addressed in the remedial design.

Hay leases will be managed by the District for areas of the farm located east of Lamb Island Road. The hay leases will specify the types of grasses and will provide for exotic species control and eradication practices.

In order to determine the effectiveness of alum to precipitate the phosphorus contained in pond solids, soils and storm waters, bench scale treatability studies were performed with the assistance of General Chemical Corporation. Alum dosages were recommended based on producing non detectable soluble P values in the treated samples.

Based upon a review of the data contained in previous studies using runoff from the pastures from 1988 through 1999 and an average total P concentration of 3.33 mg/L, the current total P load discharging from the eastern portion of the site averages from 1.7 to 2.0 tons (1.5 to 1.8 metric tons) per year (Albers et al 2000; SWET 2002). The outflow total P concentration from the proposed wetland treatment system is estimated to less than 1.0 mg/L. Using the same common technique as in previous reports, the wetland system will remove approximately 845 pounds (384 kg) of P per year. Allowing for a vegetative "grow-in" period, the treatment system will reach optimum performance within 12 – 18 months from the time of system start-up. Additional P load reduction is anticipated through volume retention and detention and P output from the farm by hay cropping. The concentration of runoff outside the HIA and high P soils is anticipated to be less than the farm average total P concentration of 3.33 mg/L used in other models.

Construction of Phase I remedial alternatives will commence in July 2003 and should be completed by the end of August 2003.

Estimated total cost of the remedial construction activities is $145,700. Details regarding the basis of design and supporting documentation are provided in the main body of the report.

1 OBJECTIVE

The objective of this project is to significantly reduce the storm water total phosphorus (P) load discharges from the Lamb Island Dairy property (Site). HSA Engineers & Scientists (HSA) has been retained by the South Florida Water Management District (SFWMD) to implement one or more remedial alternatives as recommended by an Agricultural Nutrient Management Assessment (AgNMA) to minimize P discharges from the Site. The implemented alternatives will reduce P discharges to the maximum extent practicable while taking into consideration cost effectiveness as well as the minimization of long term operation and maintenance requirements.

2 INTRODUCTION AND BACKGROUND

The Lamb Island Dairy Site, also known as Ferrell Dairy, includes approximately 808 acres in the southeast corner of Section 36 of Township 35 South, Range 33 East and in the southwest corner of Section 31 of Township 35 South, Range 34 East of Okeechobee County, Florida. Between the years of 1982-1988 there were approximately 1000-1100 head of cattle on the property, both lactating and dry. The Site was acquired by the SFWMD in 1994, in accordance with the Kissimmee River Restoration and Headwaters Revitalization Program to restore the historical river flood plains in the Cypress Slough. Per a lease agreement with the SFWMD, the previous property owner was allowed to keep beef animals on the property. All animals were removed from the Site in late 1998.

In 1990, Site dairy operations were required to be in accordance with the FDEP Dairy Rule, with a total P concentration discharge limit of 1.2 mg/L (ppm). A Works of District Permit was issued for the Site in 1997, with a lower discharge limit of 0.35 mg/L total P since the land had been converted to improved pasture (#47-00416-Q, SWET 2002). The Lake Okeechobee Protection Program has established a Total Maximum Daily Load (TMDL) of 154 tons (140 metric tons) per year for Lake Okeechobee. This relates to an in-lake concentration goal of 0.04 mg/L total P.

3 PREVIOUS STUDIES

A waste management system was designed for the Site by the USDA-Natural Resources Conservation Service (NRCS) to meet the FDEP Dairy Rule requirements. The waste management system included perimeter ditches and berms around the High Intensity Area (HIA). A 1-acre 1st stage primary settling pond (Pond 1) received the high concentration wastewater solids from the milking parlor complex (barn wash, cow spray, and runoff from the HIAs and from the perimeter ditch around the HIAs). Pond 1 water was pumped into a 2-acre facultative treatment and storage pond (Pond 2). Pond 2 water was pumped into a 5-acre facultative treatment and storage pond (Pond 3). Pond 3 water was pumped into an Eco-reactor for chemical and biological treatment. Grass was grown in the Eco-reactor and harvested periodically for feed. Excess water was pumped to a

spray field west of Lamb Island Road. **Figure 1** illustrates the Site and the previous waste management system

In 2000, Dames & Moore (D&M) conducted a waste management assessment (Dames & Moore 2000) on the Dairy including characterization of the serial waste storage ponds, HIAs, Eco-reactor and irrigation ditches as part of a closure plan. The primary phosphorus sources were identified as barn washwater, cow spray and runoff from HIAs and perimeter dike. The D&M report includes a description of the Bion wastewater treatment system that was installed at the dairy. The Bion system included treating wastewater in the settling ponds, as described above, and adding iron salts before the eco-reactor. The report analyzed different remedial alternatives with pros and cons, cost and time frame.

The SFWMD Project Team developed recommendation for the reduction of phosphorus contaminated discharges from the former Lamb Island Dairy (SFWMD 2000). The report included seven alternatives, listed below in order of their preliminary ranking by the District staff.

1. Construct contour terraces on the pastures to retain runoff, increase ET, and utilize for forage production. Collect runoff from the terrace closest to the slough and treat chemically. Incorporate soil amendments into the pastures to bind phosphorus in surface runoff and subsurface lateral flows;

2. Construct contour terraces on the pastures to retain runoff, increase ET, and utilize for forage production. Collect runoff from the terrace closest to the slough and land apply to the sprayfield. Incorporate soil amendments into the pastures to bind phosphorus in surface runoff and subsurface lateral flows;

3. Construct contour terraces on the pastures to retain runoff, increase ET, and utilize for forage production. Collect runoff from the terrace closest to the slough and treat chemically;

4. Construct contour terraces on the pastures to retain runoff, increase ET, and utilize for forage production. Collect runoff from the terrace closest to the slough and land apply to the sprayfield;

5. Construct a berm around the herd pastures to contain all surface runoff and chemically treat the runoff prior to discharge;

6. Construct a berm around the herd pastures to contain all surface water runoff and treat for phosphorus removal via a small STA or application of water to the sprayfield for nutrient uptake by forage grasses; and,

7. Construct a berm around the herd pastures and contain all surface runoff to prevent discharge to Cypress Slough.

Common to all of the alternatives listed above was the recommendation for *in-situ* bioremediation of the residual manure wastes contained in all of the existing ponds using anaerobic microbial enzymes. According to the Dames and Moore report, *in-situ* bioremediation would be accomplished by consolidating all existing manure into one lagoon, the injection of the microbes/enzymes into this treatment area, and the periodic mixing of the waste materials to ensure adequate distribution of the microbes throughout the waste materials.

4 REMEDIATION

Site remediation is comprised of two basic components:

1. Collection and Treatment of Storm Water runoff to reduce off-site discharge of Total P; and,
2. Treatment of onsite manure wastes contained in several ponds.

Further discussion of remedial measures considered feasible for each of these two basic components is provided below. The remedial treatment system is illustrated in **Figure 2**.

4.1 Surface Water Runoff Collection and Wetland Treatment System

In development of the draft 30% design the HSA Team considered both passive and more active treatment scenarios including (i) a gravity-fed only wetland treatment system, and (ii) a pump to return gravity drained storm water runoff to the wetland treatment system similar to the one proposed in (i), above. The effectiveness of these two remedial approaches was assessed based upon the following site remediation criteria or priorities[1]:

Rank	Description of Priority (or Criteria)[1]
1.	Degree of certainty in reducing phosphorus levels;
2.	Maintain agricultural productivity to harvest phosphorus from soil;
3.	Preserve value of land for agricultural productivity for financial return to District;
4.	Minimize time required to reduce phosphorus discharge concentration and loads;
5.	Minimize operating costs and complexity.

[1] (Alders et al 2000). (Please note the criteria are ranked in order of stated relative importance to the SFWMD Project Team. For instance, item 1 above, "degree of certainty in reducing phosphorus" was listed as the most important criteria ranked by the project team).

Table 1 provides a comparison of the gravity-fed system to the treatment system requiring active pumping. A score was assigned to each treatment system for each of the 5 site priority criteria established by the SFWMD as described above. A score of (1) indicates the treatment system is better able to achieve the priority description than a score of (2).

Table 1 **Comparison of Storm Water Treatment Options**			
Remediation Priorities		Treatment System Alternative	
Priority (or Criteria)	Priority Description	Gravity-fed Drawback/Advantage (Resulting Score)	Pump-fed Drawback/Advantage (Resulting Score)
1	Degree of certainty in reducing P levels	chance of dry-out of plant community during (2)	supply the wetland treatment system with a relatively constant flow of water and reduce the chance of dry-out of the plant community (1)
2	Maintain agricultural productivity to harvest P from soil	lower land requirement 43-acre storm water containment area (1)	(2) higher land requirement 117-acre storm water containment area (2)
3	Preserve value of land for agricultural productivity for financial return	Both treatment systems will equally preserve the value of the land for agricultural productivity (1)	
4	Minimize time required to reduce P discharge concentration and loads	Performance estimate: ~ 86.5 AF/yr treated ~ 1.0 mg/L total-P discharge concentration ~ 845 lb P removed (2)	Performance estimate: ~ 322 AF/yr treated ~ 0.18 mg/L total-P discharge concentration ~ 2758 lb P removed/ year (1)
5	Minimize operating costs and complexity	minimal operating costs and complexity (1)	pumping station adds approximately $5,500/year operating costs and increases the complexity (2)
A score of (1) indicates the treatment system is better able to achieve the priority description than a score of (2).			

A gravity-fed system will reduce the P load discharging from the farm and minimize operating costs and complexity therefore, achieving the project's primary objectives. The storm water runoff will be collected and stored inside a containment berm around approximately 43-acres of the HIA and high P soils. The collected runoff will flow by gravity to an onsite surface water collection and wetland treatment system. A shallow terracing berm will be constructed around approximately 109-acres at the edge of farm. The terraced area will provide P load reduction through volume retention and detention.

Storm Water Runoff Collection System

The approximate 43-acre surface water containment area will be created by constructing an earthen berm around the HIA and other high-P soils identified in the AgNMA (SWET 2002). The berms will be sized to contain at least the first two inches of storm water runoff. An overflow structure will set the maximum water level within the bermed area before storm waters are allowed to discharge from the containment area. The accumulated runoff will flow by gravity into the former eco-reactor for biological treatment. **Figure 2** illustrates the proposed containment area perimeter berm location and the AgNMA soil data (SWET 2002). The proposed berm locations were chosen based upon capturing the runoff from high P soils and to use existing swales and depressions for water storage.

Engineering and Applied Sciences (EAS) estimated the storm water runoff from the land located east of Lamb Island Dairy Road. The SFWMD provided HSA with P data used in CREAMS-WT models previously run for the property. The adICPR Model utilizing the Soil Conservation Service (SCS) Method was used to calculate runoff volume and peak discharges (EAS 2002). For runoff calculation, the input data included hydrologic soil group, land use, Curve Number (CN), rainfall amount, and time of concentration. SFWMD rainfall distribution data were used. The outputs of the adICPR runs, data sources and the runoff modeling calculations are included summarized in **Appendix A** A monthly rainfall forecast was developed using the SCS Method and historical rainfall data included in the CREAMS-WT model for the Site. **Appendix A** contains the estimated monthly runoff average and maximum volumes for a 10 year period of record. The maximum monthly runoff volume is 40.9 mgal (125.6 AF).

The containment area top of berm (TOB) elevation will be approximately two feet above grade (elevation 44 feet). The water depth will be maintained at an average of one foot above grade (elevation 43 feet) with a one foot freeboard provided. The berm height will vary depending on the existing original ground elevation and the berm dimensions will be approximately two feet wide at the top with 3:1 side slopes. The containment area will store up to approximately 43 acre-feet (53,070 m^3) of storm water runoff. **Figure 3** illustrates a typical berm and ditch cross section.

Ditches will convey the runoff to the northern side of the eco-reactor and a riser culvert will be installed to deliver storm water to the wetland treatment system. Approximately 2,700 linear feet (LF) of containment berms will be constructed on the Site.

A shallow terracing berm will also be constructed along the eastern and southern sides of the property and the storm water will pond in an approximate 109-acre terraced area and/or flow by gravity to the discharge site (see **Figure 1**). A new riser culvert will be installed upstream of the discharge site to manage the runoff from the terraced area and to maximize the volume retention in the terraced area. Collection of storm water within the terracing berm will reduce the P discharging from the property and minimize direct storm water runoff off site allowing for monitoring of the entire property east of Lamb Island

Road at one location, the KREA 44 sampling site. Approximately 5,000 linear feet (LF) of terracing berms will be constructed on the Site.

The terracing berm will be constructed by excavating a shallow swale less than 1.5 feet deep and placing the material in an adjacent berm down gradient, thus creating a terracing effect. The berm will be constructed in the location of an existing swale. Retention of the additional storm water on site will reduce the amount of P now being discharged directly off site during major storm events. The terraced area will store up to 54.5 acre-feet (67,260 m^3) of storm water runoff

Wetland Treatment System

The overall goal of the treatment system is to reduce P discharging from the Site. As indicated above, the wetland treatment system design includes collection of storm water within the 43-acre containment area. From the containment area, the water will flow by gravity to the existing eco-reactor pond. Within the eco-reactor a total of four discrete cells will be maintained and the water will flow in series from one cell to the other. Water will then flow by gravity into an existing swale prior to discharge off the property boundaries (see **Figure 2)**. Wetlands Solutions, Inc. (WSI) provided an estimate of the likely performance of a system of ponds and the eco-reactor for P reduction. The WSI memorandum is included in **Appendix B**. This preliminary information was used to estimate the performance of the wetland treatment system.

The wetland treatment system area is comprised of approximately 18.5 acres as detailed below.

- Eco-reactor Tank 1 (1.38 acres);
- Eco-reactor Tank 2 (1.12 acres);
- Eco-reactor Tank 3 (0.98 acres);
- Eco-reactor Tank 4 (3.01 acres); and,
- Existing swale (12 acres).

Water levels in the eco-reactor cells and swale will be maintained at depths of 12 to 18 inches using new riser culverts as internal water control structures. It is anticipated that emergent vegetation such as cattails will be established (volunteer growth) within the eco-reactor cells and within the boundary of the existing swale. **Figure 4** illustrates the hydraulic profile for the treatment system.

The resulting outflow total P concentration from the proposed wetland treatment system is estimated to be less than 1.0 mg/L. The treatment system will reach optimum performance in approximately 12 – 18 months during which time emergent vegetation will become established. Using an influent total P concentration of 3.3 mg/L and an outflow total P concentration of 1.0 mg/L, the wetland treatment system will reduce the total P load by approximately 70%. Additional P load reduction is expected through volume retention in the terraced area.

Using the above described wetland treatment system performance estimates, the wetland system will remove approximately 845 pounds (384 kg) of P per year. The removal assumes treating 37.2 inches (3.1 feet) of accumulated storm water runoff per year (EAS 2002) in the 43-acre containment area and is calculated by:

Influent P (lb) = 43 acres × 3.1 feet × (0.326 mgal/AF) × 3.33 mg/L × 8.34 lb/AF mgal
= 1207 lb P

Effluent P (lb) = 43 acres × 3.1 feet × (0.326 mgal/AF) × 1.0 mg/L × 8.34 lb/AF mgal
= 362 lb P

Removed P (lb) = 1207 lb – 362 lb
= 845 lb P

Staff gages will be installed at the discharge end of each eco-reactor cells and swale and the water heights will be recorded manually during routine monitoring events. The wetland system will be operated to maximize the internal storage and increase the hydraulic retention time to optimize on-site P assimilation and retention.

4.2 Treatment of Residual Manure Wastes

The land application area and the affect of applying high P waste on Site soils were discussed during the project Kick-Off Meeting. The concept of applying waste on the fields located west of Lamb Island Road was discussed. It was agreed that rather than applying the waste to low P soils on the west side of the Site, the waste will be applied to the high-P soils within the proposed containment area. Any storm water runoff produced after the waste application will be contained and treated.

HSA with technical assistance from General Chemical Corporation completed bench scale treatability studies to determine the effectiveness of alum treatment on P concentrations in pond waste, storm water, and soil at the Site. **Appendix C** contains the alum treatment treatability study worksheets and field notes.

HSA reviewed the sampling and survey data recently collected at the Site by the District. Based upon these data, a majority of the P containing waste existing at the Site is located in Pond 1. Up to 8,500 cubic yards (CY) of waste is contained in Pond 1, while Pond 2 and Pond 3 contain up to 1,500 CY and 4,325 CY, respectively. The waste located in Pond 3 is present in a very thin layer and it would be difficult and very costly to completely dewater this pond and remove the waste materials. Therefore, the manure waste alternatives only describe management of the waste in Pond 1 and Pond 2. Following are estimates of the amount of manure, total P, and total nitrogen (N) in Pond 1 and Pond 2.

Pond 1

The volume of waste contained in Pond 1 is approximately 8,500 CY. Assuming one cubic yard of wet manure waste is equal to 1,700 pounds (URS 2000), the weight of the residual solids in Pond 1 is approximately 6,600,000 kg. Based on the District data provided for Pond 1 solids, the average total P concentration is 3,012 mg/kg, the average total nitrogen (N) concentration is 20,000 mg/kg, and the average percent moisture is 71%.

The estimated amount of P in Pond 1 is:

$= [(6.6*10^6 \text{ kg}) \times (3{,}012 \text{ mg/kg}) \times (0.29) \times (1 \text{ g}/1{,}000 \text{ kg}) \times (1 \text{ lb}/ 454 \text{ g})]$
$= 12{,}700 \text{ lb P}$

The estimated amount of N in Pond 1 is:

$= [(6.6*10^6 \text{ kg}) \times (20{,}000 \text{ mg/kg}) \times (0.29) \times (1 \text{ g}/1{,}000 \text{ kg}) \times (1 \text{ lb}/ 454 \text{ g})]$
$= 84{,}320 \text{ lb N}$

Pond 2

The volume of waste in Pond 2 is approximately 1,500 CY. The weight of the residual solids in Pond 2 is approximately 1,200,000 kg. Based on the District data provided for Pond 2 solids, the average total P concentration is 4,290 mg/kg, the average total nitrogen (N) concentration is 48,595 mg/kg, and the average percent moisture is 62%.

The estimated amount of P in Pond 2 is:

$= [(1.2*10^6 \text{ kg}) \times (4{,}290 \text{ mg/kg}) \times (0.38) \times (1 \text{ g}/1{,}000 \text{ kg}) \times (1 \text{ lb}/ 454 \text{ g})]$
$= 4{,}310 \text{ lb P}$

The estimated amount of N in Pond 2 is:

$= [(1.2*10^6 \text{ kg}) \times (48{,}595 \text{ mg/kg}) \times (0.38) \times (1 \text{ g}/1{,}000 \text{ kg}) \times (1 \text{ lb}/ 454 \text{ g})]$
$= 48{,}810 \text{ lb N}$

The HSA Draft Preliminary 30% Design report proposed chemical amendment and land application of the residual manure waste. After further consideration and discussions with dairy waste management experts included on the HSA team, it has been suggested that the most cost effective waste management option that will also meet the other stated objectives of the remediation project consists of chemically amending the manure with alum and leaving the materials in-place without subsequent land spreading. Leaving the amended solids in their current location has several advantages:

- It eliminates the costs of hauling and disposing the materials to another location on or off the farm;

- It eliminates constraints and concerns relative to identified nitrogen (N) and P aerial land application rates (unless applications are planned to be incremental over an extended period of time for over three years); and
- After the solids are amended with alum the P will be immobilized making it immaterial whether the materials are moved to cropland or left in place.

Groundwater monitoring will be performed after chemical amendment to determine the groundwater quality in the area around the lagoons.

A more detailed description of this recommended option plus additional waste management alternatives evaluated for the dairy wastes are described below.

Alternative 1. Chemical Amendment and On-site/In place Disposal

Chemical treatment of the waste material and leaving the materials in-place is an attractive alternative due to the low cost. The waste materials in Pond 2 would be pumped into Pond 1 and pumps or a backhoe would be used to further slurry or mix the waste. Liquid alum would be carefully metered into the slurry and the waste would be further mixed to provide adequate solids contact. After chemical amendment dewatering and consolidation, Pond 1 and Pond 2 would be backfilled with native fill material.

HSA, with technical assistance from General Chemical Corporation, completed bench scale treatability studies to determine the effectiveness of alum treatment on P concentrations in pond waste. **Appendix C** contains the details of alum treatability study worksheets and field notes. The treatability studies showed that the chemically treated waste contained negligible concentrations of soluble P.

Alternative 2. In-Situ Bioremediation

In-situ bio-remediation uses microbial enzymes to reduce the solids and nutrients concentrations in the waste material. Bio-remediation is a largely unproven technology with most of the reference material available from bench-scale and pilot scale studies. In this approach, the waste material would be accumulated in Pond 1 and a dry powder bacterial product would be added to the material. The material would be mixed and agitated. Subsequent bacterial doses would be applied weekly and the waste would be routinely agitated until the solids and/or nutrient concentrations have been sufficiently reduced. The treatment time for bioremediation is estimated from a minimum of 90 days to one year or potentially longer.

Vendors report up to a 60% reduction in total volatile solids and 60% - 80% reduction in nutrient (nitrogen) concentrations. A treatability study would need to be completed to determine the effectiveness of the microbial product and to estimate the remedial treatment time if this alternative were to be pursued. The dairy waste management experts on the HSA team have discouraged the use of this type of bioremediation on this project. Due to experts' advice and the unknowns associated with this alternative, bioremediation does not appear to be viable for the following reasons:

- The treatment time for microbial enzyme bioremediation is estimated from a minimum of 90 days to one year or potentially longer. This time period is much longer than the other proposed alternatives;
- Microbial enzyme bio-remediation is a largely unproven technology for treating dairy wastes in the prescribed manner with most of the reference material available from bench-scale and pilot scale studies; and,
- Bio-remediation treatment would not achieve any reduction of P, the key nutrient.

Testing is planned to further investigate bioremediation at the site. Alternative waste management alternatives will be presented, if necessary, in subsequent design documents for comment by the Interagency team.

Alternative 3. Chemical Treatment and Land Application

The residual solids would be removed from Pond 1 and treated with alum prior to land application to produce a mixture with essentially no soluble P. The solids in Pond 1 would be mixed into a slurry and pumped into tanker trucks. Existing pond water would be used as make-up water, as necessary, to slurry the waste. Alum would be added to the waste at a rate of approximately 3240 milligrams of alum per liter of waste. The chemically amended solids would then be applied uniformly over the available land.

The relatively small quantity of residual solids in Pond 2 is present in thin layers and it would be difficult and costly to remove these solids in the manner proposed for Pond 1. The alternate Pond 2 proposed treatment technique is to first pump Pond 2 water into Pond 3. The remaining residual solids in Pond 2 would dry-out and then Pond 1 and Pond 2 would be backfilled with native fill material.

As calculated above, there are approximately 12,700 lb of P and 84,320 lb N in Pond 1. Based on application rates of 60 lb P per acre and 160 lb N per acre the following land areas are required for land application.

Phosphorus: 12,700 lb P ÷ 60 lb P/ acre
= 212 acres

Nitrogen 84,320 lb N ÷ 160 lb N/ acre
= 527 acres

The land application strategies and the effect of applying nutrient rich waste on Site soils were discussed during the project Kick-Off Meeting. The concept of applying waste on the fields located west of Lamb Island Road was also discussed. It was agreed that rather than applying the waste to low P soils on the west side of the Site, the waste would be applied on the land located on the east side of Lamb Island Road. The waste would be evenly applied to the soils within the 152-acre containment area during multiple applications for a period of approximately 3.5 years (527 acres required ÷ 152-acre containment area). The application period would be reduced if the material was also

spread over cropland located west of Lamb Island Road. Multiple applications will increase costs by re-mobilizing lagoon cleaning and land spreading equipment.

The treatability studies showed that the chemically treated waste contained negligible concentrations of soluble P. The treatability studies conducted also indicated that an additional 20-25% reduction in available soil P would result from the application of the chemically amended waste (see **Appendix C**). The application of amended wastes would provide an added benefit of reducing leachable P concentration from the soil after application.

Alternative 4. Off-Site Landfill Disposal

Excavation and disposal of the waste material at a landfill is an attractive alternative due to the almost immediate cleanup timeframe. The disadvantage is the cost associated with material transportation and disposal. Another potential drawback is the message this waste management alternative sends to other land owners in the watershed that the preferred waste management alternative is to transport their waste to another location for disposal.

Waste Management Alternatives Evaluation

The waste management alternatives were evaluated based upon the following site remediation priorities, listed in no particular order:

- Degree of certainty in reducing P levels;
- Time required for treatment; and,
- Estimated cost for implementation.

Table 2 provides a comparison of the waste management alternatives and a scoring based on the ability of each treatment system to achieve the remediation priorities listed above. A score of (1) indicates the treatment system better able to achieve the priority description than a higher score of (2).

Table 2 **Comparison of Waste Treatment Options**				
Waste Treatment Option				
Criterion	Alum amendment and disposal in-place	Alum amendment and land spreading	Microbial enzyme bio-remediation	Off-site disposal
Degree of certainty in reducing P levels	(1) chemical amendment will immediately reduce P concentration	(1) chemical amendment will immediately reduce P concentration	(2) Uncertain P reduction	(1) Immediate P reduction by removing waste from the site
Time required for implementation	(1) 0-2 weeks	(3) multiple applications over 3.5 years	(2) 90 days to 1 year	(1) 0-2 weeks
Cost estimate	(1) $20,000	(3) $93,200	(2) $47,000	(4) $290,000
A score of (1) indicates the treatment system is better able to achieve the priority description than a score of (2).				

The recommended alternative for the remediation of the wastes contained in the onsite ponds is to chemically amend with alum and dispose of in place.

As part of the remediation measures planned for the wastes solids, the water columns in ponds 2 and 3 overlaying the waste materials will be chemically treated with alum. In addition, the old borrow pit/ cooling pond at the southeast area of the property will be treated with alum. Storm water treatment using alum is a cost effective method for immediate P reduction in standing water and since ponds 2 and 3 and the cooling pond contain total P concentrations in the range of 4 to as high as 10 mg/l P, they are strong candidates for alum treatment.

Treatability studies completed by General Chemical and HSA have determined that a maximum alum dosage of about 1000 mg/L will be required. A boat carrying a drum of concentrated alum and associated pumps will be used to add alum into the water column. Alum will be carefully metered at a predetermined rate during application on a pre-established grid to evenly apply the alum to the water surface. The produced floc will settle, incorporate into the pond sediment and the resulting soluble P in the water column will be negligible. Treating the pond water with alum will also enhance inactivation of the P in the pond sediments. Based on the District survey data, approximately 32 mgal will need be treated (4.32 mgal in Pond 2, 26.9 mgal in Pond 3, and 0.80 mgal in cooling pond). Pond water treatability study details and supporting data are included in **Appendix C**.

Numerous studies have been conducted using alum residuals to reduce nutrient runoff from agricultural land treated with animal manures. One study concluded that land application of alum residuals provides a safe and inexpensive solution to reduce nutrient runoff from agricultural land (Basta and Storm, 1997). The phosphate mineral that forms after soils are amended with aluminum sulfate (alum) are not expected to later dissolve if the soil becomes acidic (Moore et al., 1998). Studies have been conducted which tested the phosphorus availability in soils amended with water treatment residuals (WTR) derived from water treatment with aluminum and iron salt coagulants. One such study concluded that P concentrations on agricultural land can be rapidly reduced by application of WTR. Reduction of extractable and soluble P concentrations should reduce the amount of P that is transported from a field in runoff or leachate (Hyde and Morris, 2000). These references and others are available on request.

Limited reference material is available on using alum in dairy lagoons, but experiments have been conducted by the Texas Agricultural Experiment Station. Poster presentations by Mr. Ron Jones of the Texas Agricultural Experiment Station are available on his web site at the following locations:

http://stephenville.tamu.edu/~rjones/poster.htm
http://stephenville.tamu.edu/~rjones/2000poster.htm
http://stephenville.tamu.edu/~rjones/2001poster.htm

Mr. Jones also published a paper at the American Society of Agricultural Engineers (ASAE) symposium held in 2000 in Des Moines, Iowa (Jones, R.M. and S.P. Brown. Chemical and settling treatment of dairy wastewater for solids separation and phosphorus removal, pp. 132-141, Proceedings of the Eighth International Symposium on Animal, Agriculture and Food Processing Wastes.).

The existing settling ponds (Ponds 1, 2, and 3) will not be used in the revised storage/treatment system. The remedial activities proposed include removal of the manure waste from Pond 1 and Pond 2. These areas will be graded and included in the surface water containment area. According to the AgNMA prepared for the Lamb Island Dairy (SWET 2002), this pond cleaning procedure will meet the NRCS requirements for waste pond closure.

4.3 HIA Perimeter Ditch

A perimeter ditch and dike were constructed to collect runoff and shallow groundwater from the HIAs. The ditch system consists of seven small ponds connected by culverts. The AgNMA recommended that the small quantity of waste manure existing in the ditches should be buried in-place (SWET 2002). After the culverts are removed, the ditches will be backfilled and graded and included in the surface water containment area.

4.4 Cropping

HSA agrees with the recommendations from the SFWMD to negotiate cropping leases for the property. Cropping should begin after construction of Phase I remedial activities is completed. The most likely crop is hay which can be readily utilized by local dairy operations. Hay leases will be managed by the SFWMD and will specify the types of grasses and will provide for exotic species control and eradication practices.

5 SCHEDULE

The remedial alternatives recommended will not cause any changes to the project completion schedule previously proposed. A copy of the Project Completion Schedule is included in **Appendix D**. Phase I construction activities will be completed by September 2003 and monitoring will continue through September 2004.

6 PERMITTING

In accordance with section 373.406 (9), F.S., the SFWMD and the FDEP are authorized to exempt, from Environmental Resource Permitting, certain activities, conducted on agricultural lands, that are determined to be primarily for the purpose of environmental restoration or water quality improvement with only minimal or insignificant cumulative adverse impact. Projects may be exempted from Environmental Resource Permitting for construction of structures on public of privately owned land for retaining or treating

water on such land for the primary purpose of environmental restoration or water quality improvement on agricultural lands.

7 MONITORING

HSA proposes collecting the following samples during implementation of the remedial alternative:

1. Raw residual manure solids and chemically treated solids;
2. Raw pond water and chemically treated pond water samples (Pond 3 and cooling pond);
3. Groundwater samples from the existing monitor well; and,
4. KREA 44 surface water samples, if available.

The samples will be analyzed for total P, soluble P, and total aluminum. The analytical data will be used to estimate the load reduction after chemical treatment and provide recent baseline data (groundwater and KREA 44) before treatment system start-up.

After construction, site visits will be conducted on a bi-weekly basis to monitor the performance of the wetland treatment system. The proposed monitoring plan will not include monitoring storm water run off from the farm west of Lamb Island Road and land outside the treatment system. Surface water samples will be collected at the KREA 44 location whenever a site visit corresponds with runoff at the monitoring site. Groundwater samples will be collected quarterly. The samples will be analyzed on-site for water quality parameters (DO, temperature, conductivity, pH, turbidity) and submitted to for laboratory analysis for total P, soluble P, and total aluminum.

The following activities will be completed during each monitoring visit:

- Inspect the berms and water controls structures; and,
- Record the water level at control structures, in the ponds, and in the eco-reactor.

8 COST ESTIMATE

The cost estimate included in the draft 30% design was for a more active remedial approach using a pump station to deliver storm water to the wetland treatment system. The following costs are associated with a passive scenario, where storm water is gravity-fed to the wetland treatment system. **Table 3** summarizes the cost estimate calculations.

These costs will be further evaluated and detailed further in the Detailed 90% Design Package.

TABLE 3
Lamb Island Dairy
Remedial Activities Cost Estimate

Date:	01/13/2003(R)
Prepared by:	T. Horan
Checked by:	T. Emenhiser
Ref #:	8005.7106.00
Project Name:	Lamb Island Dairy

II. EXPENSES

Description	Rate	Unit	# units	Total
Containment area				
Berms				
Perimeter berm/ditches (0-2 ft)	$ 12.50	LF	2700	$ 33,750
Shallow terracing berm (< 1.5 feet)	$ 1.75	LF	5000	$ 8,750
Subtotal				**$ 42,500**
Manure waste management				
Labor and equipment	$ 15,300.000	L.S.	1	$ 15,300
Chemical treatment				
Alum	$ 0.54	gallons	8719	$ 4,700
Subtotal				**$ 20,000**
Pond Water				
Treat the existing water column ponds				
Alum cost (Ponds 2 and 3)	$ 200.000	mgal	31.2	$ 6,240
Cooling pond	$ 200.000	mgal	0.8	$ 160
Mixing alum into water column	$ 15,000.00	L.S.	1	$ 15,000
Subtotal				**$ 21,400**
Treatment system				
Install/ repair berms and water control structures	$ 25,000.00	L.S.	1	$ 25,000
Subtotal				**$ 25,000**

HIA Perimeter Ditch				
Dewater and grade	$ 5,000.00	L.S.	1	$ 5,000
Subtotal				**$ 5,000**
Monitoring stations				
Develop monitoring station	$ 5,000.00	L.S.	1	$ 5,000
Subtotal				**$ 5,000**
			SUBTOTAL	**$ 118,900**
		CONSTRUCTION CONTINGENCY (20%)		**$ 23,800**
ADDITIONAL SERVICES				
Surveying				
Survey ditch and berm area/ elevation	$ 750.00	day	2	$ 1,500
Analytical services				
Total and soluble P analysis of samples collected during implementation (3 pre and post treatment samples for each medium + QA/QC)	$ 20.00	sample	75	$ 1,500
Subtotal				**$ 3,000**

TABLE 3
Lamb Island Dairy
Remedial Activities Cost Estimate

			TOTAL:	**$ 145,700**
Phase II Alternatives				
Storm water runoff chemical treatment system				
Chemical treatment system (shed, tanks, piping, slab, metering pumps, etc.)	$ 35,000.00	L.S.	1	$ 35,000
Electrician (power drop, electrify pump and chemical treatment system)	$ 2,500.00	L.S.	1	$ 2,500
Chemical treatment system O&M (chemicals, replacement parts, electricity, etc.)	$ 2,780.00	year	1	$ 2,780
Subtotal				$ 40,280

Surface Water Containment Area

Berms - Approximately 2,700 linear feet (LF) of berms approximately two feet high will be constructed. The estimated berm costs:

= (2,700 LF * $12.50/LF)

Cost = $33,750

This cost is equivalent to approximately $0.80 per cubic foot of berm constructed.

Shallow terracing – Approximately 5,000 linear feet (LF) of shallow terracing berm (less than 1.5 feet tall) will be constructed. The estimated shallow terracing berm costs:

= (5,000 LF * $1.75/LF)

Cost = $8,750

This cost is equivalent to approximately $0.25 per cubic foot of shallow terracing berm constructed.

The total cost estimated to construct the surface water containment area is approximately $42,500.

Manure Waste Management

Costs have been provided below for the different manure waste management alternatives. The total project cost includes the costs associated with one manure management alternative, chemical amendment and on-site disposal.

Chemical Amendment and On-site Treatment (Recommended Option)

Chemical costs – Approximately 8,719 gallons of alum will be used at a unit rate of $0.54 per gallon.

Cost = $4,700

The labor and equipment cost associated with chemical addition, periodic mixing, and monitoring is $15,300.

The total cost estimated for chemical amendment and on-site disposal is approximately $20,000.

In-Situ Bioremediation (Evaluated but not Recommended)

HSA obtained information related to microbial enzyme bioremediation from Desert Microbial Products and Mr. Bill Hughbanks, President, recommended an initial heavy dose of microbes ($2,000) followed by weekly maintenance doses with a heavier dose every fourth month ($1,000/ month). The treatment time is estimated from 90 days to one year. Using an average treatment time of 7.5 months the microbes cost are calculated by:

$2,000 initial dose + (7.5 months treatment × $1,000/month) = $9,500

The labor and equipment cost associated with the routine agitation of the waste material is approximately $5,000 per month. Using an average treatment time of 7.5 months the labor/ equipment cost is $37,500 ($5,000 per month × 7.5 months).

The total cost estimated for in-situ bioremediation is approximately $47,000.

Chemical Treatment and Land Application (Not Recommended)

A total of approximately 3.5 mgal of waste, including make-up water, will be removed, treated with alum, and spread onto the soils inside the containment area. The material will be applied annually over a period of 3.5 years (i.e., total of 4 individual solids applications).

Waste removal and land application – Approximately 3.5 mgal materials removed and land applied at a unit cost of $0.021 per gallon.

Cost = $ 73,500

Chemical costs – Approximately 8,719 gallons of alum will be used at a unit rate of $0.54 per gallon.

Cost = $4,700

The remaining storm water from Pond 2 will be pumped into Pond 3 for pond water chemical treatment. The residual solids in Pond 2 will be allowed to dry-out and will be land applied. These costs will be elaborated upon approval of this approach. A budgetary allowance of $15,000 has been used for these tasks.

The total cost estimated for waste removal, alum treatment, and land application is $ 93,200.

Off-Site Landfill Disposal (Evaluated but not Recommended)

Excavation and disposal of the waste material at a landfill is an attractive alternative due to the almost immediate cleanup timeframe. The disadvantage is the cost associated with

transportation and disposal and the material may not be dry enough to be accepted by the landfill.

Based upon the Dames & Moore report (URS, April 10, 2000) the cost for excavation, transportation, and disposal at a local landfill is approximately $40 per ton. The waste material remaining in Pond 1 is calculated by:

8,500 yd^3 × (1,700 lb/yd^3) × (1 ton/1,000 gallons) = 7,225 tons

The cost estimated for excavation and off-site disposal is approximately $290,000 ($40/ton × 7,225 tons).

Pond Water

Ponds 2 and 3 contain a total of approximately 31.2 mgal of storm water. An additional 0.80 mgal of storm water is present in the former animal cooling pond located near the discharge site. This results in a total volume of approximately 32 mgal gallons of pond water to be treated. The chemical cost to treat the storm water with alum ($200/mgal) is approximately $6,400. The cost to use a boat and storage tanks and meter the chemical into the water column is approximately $15,000.

Cost = $21,400 (labor included)

Wetland Treatment System

The berms in the eco-reactor will be refurbished, as necessary, and water control structures will be installed to maintain the hydraulic profile previously discussed. A water control structure will also be installed upstream of the discharge site to manage the storm water in the terraced area. The condition of the existing berms and control structures will be investigated and exact costs will be detailed in the Detailed 90% Design Package. A budgetary allowance for these items is approximately $25,000.

HIA Perimeter Ditch

The culverts will be removed and disposed and the ditches will backfilled and graded and included in the surface water containment area. A budgetary allowance of approximately $5,000 has been made for these services.

Monitoring Stations

The proposed monitoring station will be further developed with excavation and/or water control structures, as necessary. The scope of these services will be detailed in the Detailed 90% Design Package. A budgetary allowance of approximately $5,000 has been made.

Additional Professional Services

Surveying services ($1,500) will be required during lay-out and construction of the berm, ditches, overflow and water control structures. Analytical services ($1,500) will be required to analyze samples collected during implementation of the remedial alternatives.

Cost = $3,000

Total Cost Estimate (Recommended Remediation Activities)

The cost estimate to implement the remedial activities including:

1. Construction of a containment berm around 43-acres of high P soils and a shallow terracing berm around 109-acres at the edge of farm to collect and store runoff;
2. Pond 1 and Pond 2 waste solids treatment with alum and in-place containment;
3. Backfilling the perimeter ditch; and,
4. Surface water collection and wetland treatment.

is approximately $145,700, as described below.

Construction Costs	$118,900
20% Construction Contingency Cost	$ 23,800
Additional Professional Services (surveying, analytical, and permitting)	$ 3,000
Total	$145,700

9.0 REFERENCES

Albers, Joe, J. La ing, S. Olson, S. Ray, G. Ritter, B. Whalen, J. Zhang. 2000. Preliminary Design Report, Lamb Island Dairy Recommendations to Eliminate Phosphorus Contaminated Discharges; Okeechobee County, Florida.

Basta, Nick and Storm, Dan, August 3-6, 1997. Use of Alum Residuals to Reduce Nutrient Runoff From Agricultural Land Treated With Animal Manures to Protect Surface Water Quality, WEF/AWWA Joint Management Conference: Water Residuals and Biosolids Management: Approaching the Year 2000.

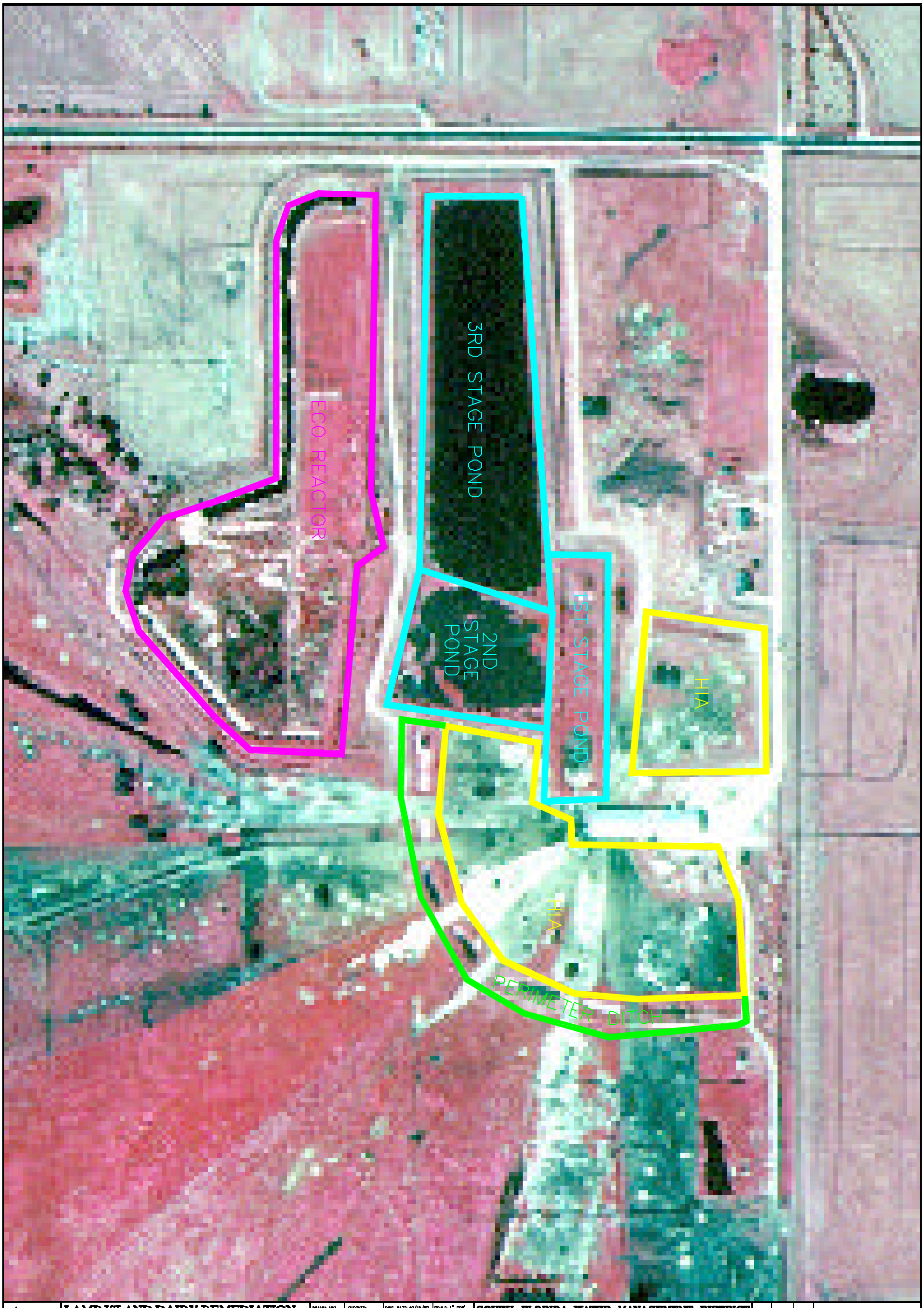
Dames & Moore. 2000. Waste Management Assessment, Ferrell Dairy property, Okeechobee County, Florida. Prepared for South Florida Water Management District, Job Number 10582-117-024.

J.E. Hyde and T.F. Morris, November-December 2000. Phosphorus Availability in Soils Amended with Dewatered Water Treatment Residual and Metal Concentrations with Time in Residual. J.E. Hyde and T.F. Morris, J. Environ. Qual., Vol. 29.

P.A. Moore, Jr., W.F. Jaynes and D.M. Miller, 1998. Effect of pH on the Solubility of Phosphate Minerals, Proceedings: National Poultry Waste Management Symposium.

Soil and Water Engineering Technology, Inc. July 5, 2002. Agriculture Nutrient Management Assessment for Lamb Island Dairy Buyout Farm. For Florida Department of Agriculture and Consumer Services.

Wetland Solutions, Inc. October 16, 2002. Estimated Performance of the Proposed Lamb Island Dairy Remediation Project.



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	FIELD PERSONNEL:			
	FIELD DATE(S):			
	FIELD BOOK(S):			
	PAGE(S):			
	DATA COLLECTOR FILE(S):			

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING & PROJECT MANAGEMENT DEPARTMENT
P.O. BOX 24680
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33416-4680

DRAWN	CHECKED	DATE	REVISIONS

ECO-REACTOR

FLOW DIRECTION

DISCHARGE LOCATION

Sheet 3

MATCH LINE – SEE SHEET 4

MATCH LINE – SEE SHEET 3

MATCH LINE

Chandler Slough

LEGEND

PROPOSED TERRACED BERM

PROPOSED CONTAINMENT BERM

SOIL SAMPLE LOCATION

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING & PROJECT MANAGEMENT DEPARTMENT
P.O. BOX 24680
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33416-4680

LAMB ISLAND DAIRY REMEDIATION
PROPOSED TREATMENT SYSTEM
OKEECHOBEE COUNTY, FLORIDA
SECTION 31
TOWNSHIP 36 SOUTH
RANGE 34 EAST

CADD FILE NO.
DRAWING NO.

2 SHEET OF 4

REVISIONS | DATE | DRAWN/CHECKED

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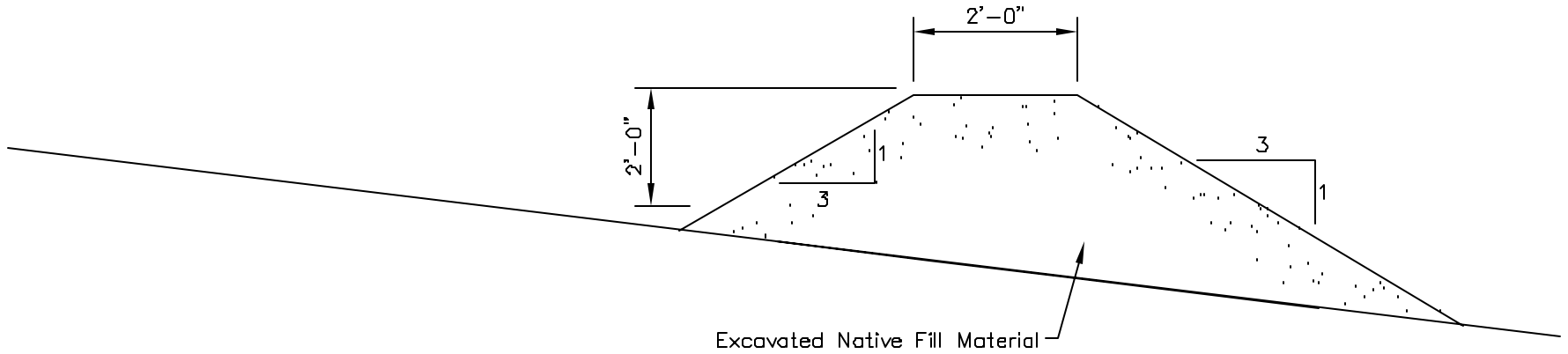

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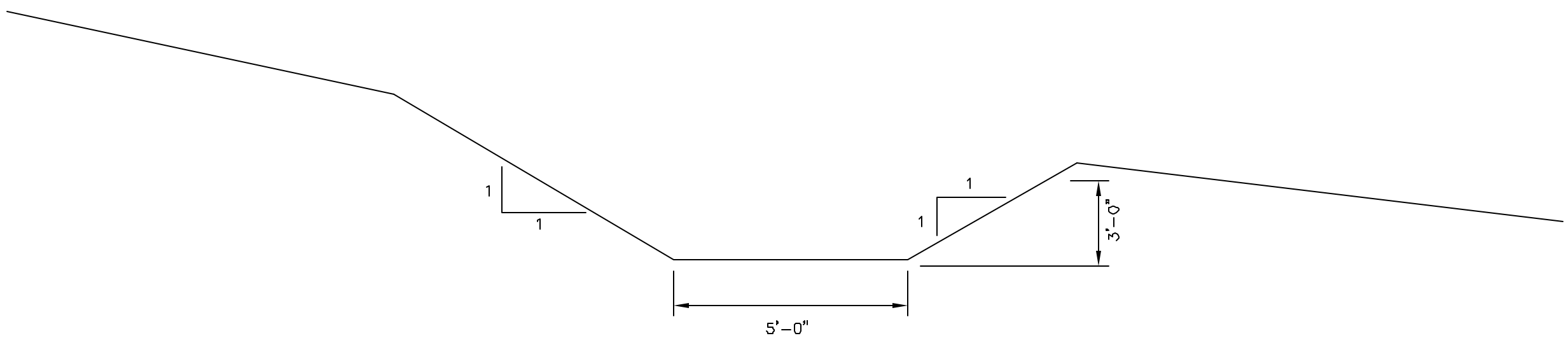

DITCH CROSS SECTION DETAIL

REVISIONS	DATE	DRAWN/CHECKED

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENGINEERING & PROJECT MANAGEMENT DEPARTMENT
P.O. BOX 24680
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WEST PALM BEACH, FLORIDA 33416-4680

DRAWN BY:	CHECKED	DWG. INITIAL NO./LNGTH	SCALE
FIELD CREW(S):			
FIELD BOOK(S):			
PHASE(S):			
DATA COLLECTION FILE(S):			

LAMB ISLAND DAIRY REMEDIATION
DETAILS
OKEECHOBEE COUNTY, FLORIDA
SECTION 31
TOWNSHIP 38 SOUTH
RANGE 34 EAST

CADD FILE NO.
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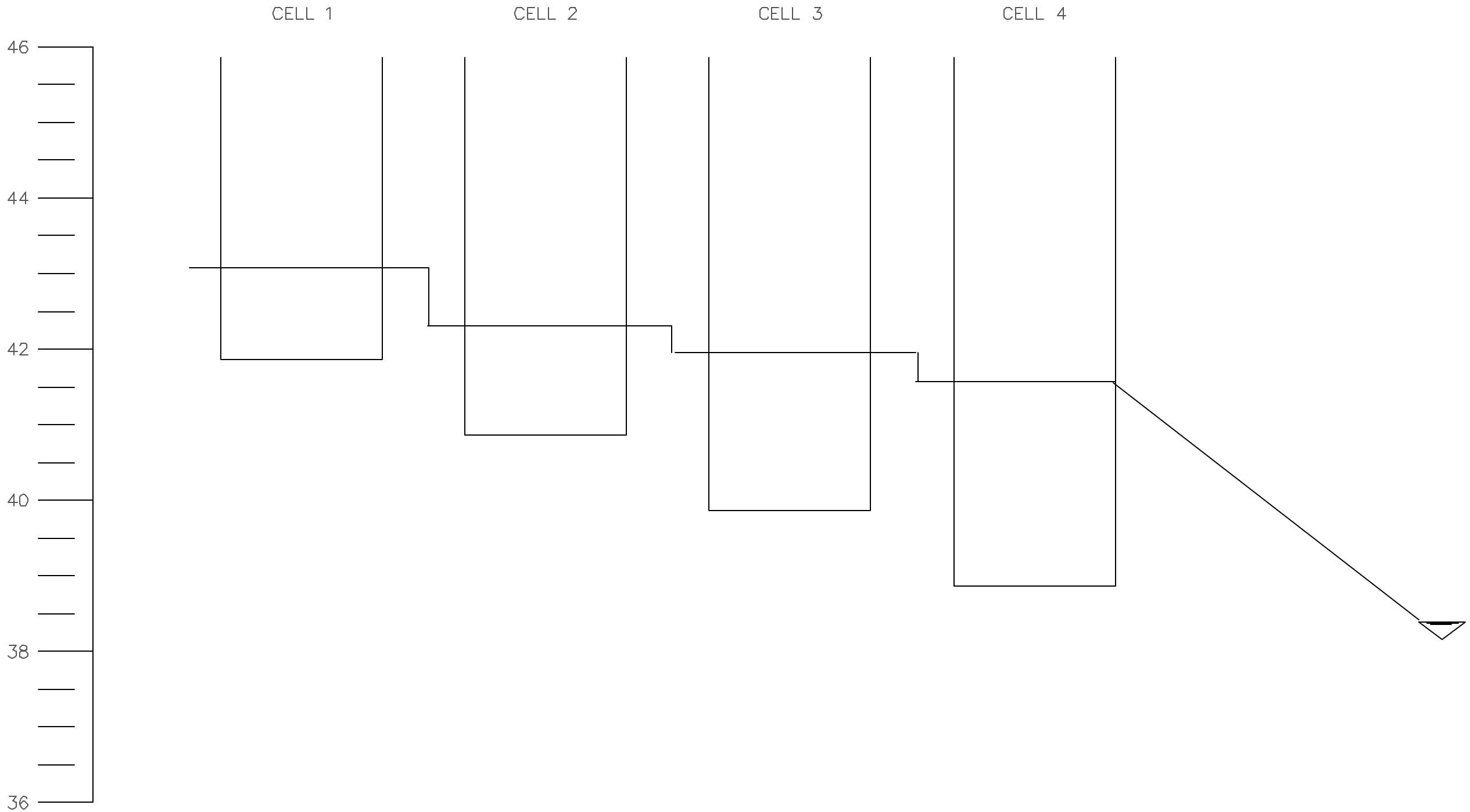
DRAWING NO.
3
SHEET
3 OF 4

ECO-REACTOR



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FIELD BOOK(S):
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MASTER:
DATA COLLECTION FILE(S):

LAMB ISLAND DAIRY REMEDIATION
HYDRAULIC PROFILE
OKEECHOBEE COUNTY, FLORIDA
SECTION 31
TOWNSHIP 37 SOUTH
RANGE 35 EAST

CADD FILE NO.
DRAWING NO.
4
SHEET OF 4

APPENDIX A

RUNOFF MODELING CALCULATIONS

Table 1
Run off Estimation Summary

Area No.	1	2	3
Area Name	Containment Area	Outside Containment Area	Treatment Area
Drainage Area (acres)	116.7	106.8	22.4
Rainfall - 10 year - 24 hour (in)	8.00	8.00	8.00
Storm duration (hr)	24	24	24
10-Yr, 24-hr runoff volume (in)	6.7	6.68	7.76
10-Yr, 24-hr runoff volume (ft^3)	2830533	2590140	630785
10-Yr, 24-hr runoff volume (cfs)	304.8	299.78	37.85
10-Yr, 24-hr runoff volume (mgal)	21.2	19.4	4.7
10-Yr, 24-hr runoff volume (AF)	64.9	59.4	14.5
Area water height (in)	21.6	21.6	18.6
Notes:			
in = inches			
hr = hour			
ft^3 = cubic feet			
cfs = cubic feet per second			
mgal = million gallons			
AF = acre feet			

TABLE 2
Estimated Average and Maximum Monthly Runoff Volumes

	CN	S(max. soil storage)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Avg. Monthly Rainfall (inches)			2.7	2.5	4.0	3.2	3.8	7.1	5.8	7.9	6.3	4.2	1.7	1.7
Runoff (inches)-Basin #1 - Contained Area	89	1.24	1.63	1.45	2.82	2.08	2.64	5.81	4.54	6.59	5.03	3.01	0.78	0.78
Runoff (inches)-Basin #2 - Outside of Contained Area	89	1.24	1.63	1.45	2.82	2.08	2.64	5.81	4.54	6.59	5.03	3.01	0.78	0.78
Runoff (inches)-Basin #3 - Treatment Area	98	0.20	1.41	1.24	3.77	2.97	3.57	6.86	5.56	7.66	6.06	3.96	1.48	1.48
Max. Monthly Rainfall (inches)			6.9	5.9	7.9	8.0	10.3	14.3	10.0	11.8	10.3	7.9	3.8	5.5
Runoff (inches)-Basin #1 - Contained Area	89	1.24	5.61	4.64	6.59	6.69	8.95	12.92	8.66	10.44	8.95	6.59	2.64	4.25
Runoff (inches)-Basin #2 - Outside of Contained Area	89	1.24	5.61	4.64	6.59	6.69	8.95	12.92	8.66	10.44	8.95	6.59	2.64	4.25
Runoff (inches)-Basin #3 - Treatment Area	98	0.20	5.37	4.40	7.66	7.76	10.06	14.06	9.76	11.56	10.06	7.66	3.57	5.26

	CN	S(max. soil storage)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Avg. Monthly Rainfall (inches)			2.7	2.5	4.0	3.2	3.8	7.1	5.8	7.9	6.3	4.2	1.7	1.7
Runoff (ac-ft)-Basin #1 - Contained Area	89	1.24	15.86	14.15	27.45	20.24	25.63	56.46	44.17	64.08	48.88	29.28	7.63	7.63
Runoff (ac-ft)-Basin #2 - Outside of Contained Area	89	1.24	14.52	12.95	25.13	18.53	23.46	51.67	40.42	58.64	44.74	26.80	6.99	6.99
Runoff (ac-ft)-Basin #3 - Treatment Area	98	0.20	2.63	2.31	7.03	5.54	6.66	12.81	10.38	14.30	11.31	7.40	2.76	2.76
Max. Monthly Rainfall (inches)			6.9	5.9	7.9	8.0	10.3	14.3	10.0	11.8	10.3	7.9	3.8	5.5
Runoff (ac-ft)-Basin #1 - Contained Area	89	1.24	54.56	45.11	64.08	65.03	87.06	125.62	84.18	101.49	87.06	64.08	25.63	41.35
Runoff (ac-ft)-Basin #2 - Outside of Contained Area	89	1.24	49.93	41.28	58.64	59.51	79.67	114.96	77.04	92.88	79.67	58.64	23.46	37.85
Runoff (ac-ft)-Basin #3 - Treatment Area	98	0.20	10.03	8.22	14.30	14.49	18.78	26.24	18.22	21.58	18.78	14.30	6.66	9.82

*** Runoff depth is calculated based on SCS method; Q=(P-0.2*S)^2/(P+0.8S) and S=(1000/CN-10).**

*** Runoff volume is calculated based on SCS method; Volume=Q*Area/12**

Runoff Estimation of Lamb Diary Farm

1. Project Area

Lamb Diary Farm is a 808-acre farm in the southeast corner of Section 36 of Township 35 South, Range 33 East and in the southwest corner of Section 31 of Township 35 South, Range 34 East of Okeechobee County, Florida (see attachment #1).

For runoff estimation purpose, three areas are delineated: (1) the containment area; (2) The area outside the containment area; (3) the treatment area. See Attachment #1.

2. Method Used

The SCS method was used to calculated runoff volume and peak discharge for these three areas. The adICPR model was used to calculate the runoff volume and peak discharges. Four rainfall events are calculated: 10-year 72-hour, 10-year 24hr, 25-year 72 hour, and 100-year 72 hour events. South Florida Water Management District rainfall distribution was used.

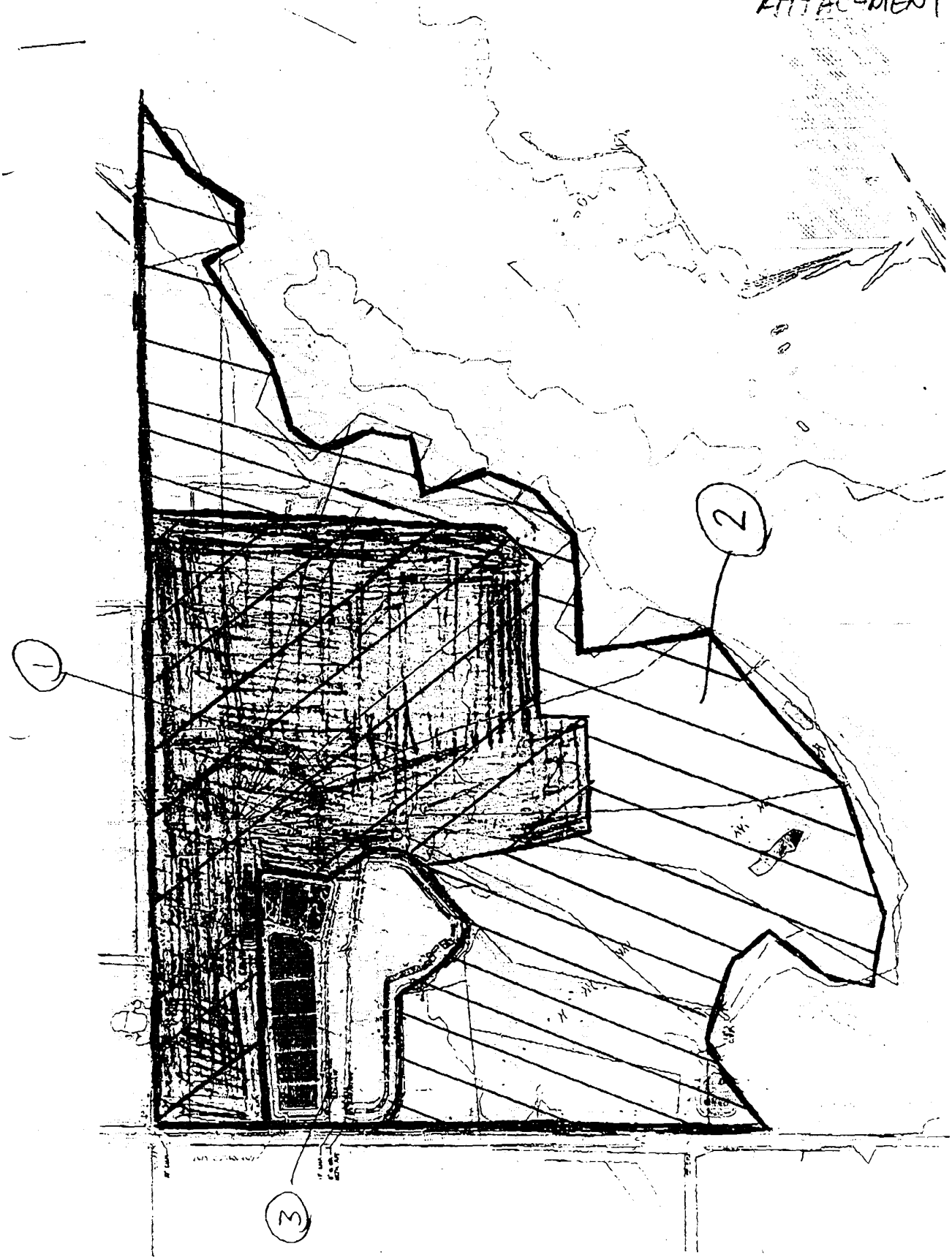
3. Input Data

For runoff calculation, the input data include hydrologic soil group, land use, Curve Number (CN), rainfall amount for 10-year, 25-year, and 100-year events, and time of concentration. The supporting data are included in Attachment #2.

4. Output

Outputs of the adICPR runs include: (1) summary of total runoff volumes and peak discharges; and (2) rainfall and runoff time distributions as attachment #3 and #4.

ATTACHMENT #1



	Area 1 Containment area	Area 2 - Outside the containment area	Area 3 -Treatment area
Drainage Area (acres)	116.7	106.8	22.4
Soil Type	Myakka fine sand	Myakka fine sand	Myakka fne sand
Hydrologic soil group	Hydrologic soil group: B/D	Hydrologic soil group: B/D	Hydrologic soil group: B/D
Land use	Poor pasutre	Poor pasture	Pond
CN	79/89	79/89	79/89
Rainfall -10year-72HR (Inches)	10	10	10
Rainfall -25year-72HR (Inches)	11	11	11
Rainfall -100year-72HR (inches)	15	15	15
Peak Factor	256	256	256
Storm Duration (hr)	72	72	72
Time of Concentration,TC(min)			
Concentrated Flow Length (ft)	2300	2000	900
Channel flow Length (ft)	0	0	1400
Slope of Basin (ft/ft)	0.00290	0.00250	0.00250
Channel Slope	0.002	0.002	0.002
Average V for shallow Concentrated flow	1.2	1.2	1.2
T1- Time of Concentration,TC-shallow concentrated flow (min)	31.9	27.8	12.5
T2 -Time of cConcentration Channel Flow			62.4
N-roughness			0.05
R- hydraulic radius (ft)			4.00
Slope of channel			0.001
V(ft/sec)			0.37
Tc=T1 + T2 (min)	32	28	75

ATTACHMENT #9

	Area 1 Containment Area	Area 2 - Outside the containment area	Area 3 - Treatment Area
Drainage Area (acres)	116.7	106.8	22.4
10-YR, 72HR Runoff Volume (cu-ft)	3664211	3354280	793267
10-YR, 72HR Max flow (cfs)	300	296	35
10-YR, 24HR Runoff Volume (cu-ft)	2830533	2590140	630785
10-YR, 24HR Max flow (cfs)	304	299	38
25-YR, 72HR Runoff Volume (cu-ft)	4082642	3737306	4169593
25-YR, 72HR Max flow (cfs)	332	328	52
100-YR, 72HR Runoff Volume (cu-ft)	5762505	5275032	1199578
100-YR, 72HR Max flow (cfs)	458	452	183

ATTACHMENT 3

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [1]

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Summary - P10 **********

***					
Basin Name:	AREA1	AREA2	AREA3	AREA1B	AREA1C
Group Name:	BASE	BASE	BASE	BASE	BASE
Node Name:	AREA1	AREA2	AREA3	AREA1B	AREA1C
Hydrograph Type:	UH	UH	UH	UH	UH
Unit Hydrograph:	UH256	UH256	UH256	UH256	UH256
Peaking Factor:	256.00	256.00	256.00	256.00	256.00
Spec Time Inc (min):	4.27	3.73	10.00	4.27	4.27
Comp Time Inc (min):	4.27	3.73	10.00	4.27	4.27
Rainfall File:	SFWMD72	SFWMD72	SFWMD72	SFWMD72	SFWMD72
Rainfall Amount (in):	10.00	10.00	10.00	11.00	15.00
Storm Duration (hr):	72.00	72.00	72.00	72.00	72.00
Status:	ONSITE	ONSITE	ONSITE	ONSITE	ONSITE
Time of Conc. (min):	32.00	28.00	75.00	32.00	32.00
Lag Time (hr):	0.00	0.00	0.00	0.00	0.00
Area (acres):	116.70	106.80	22.40	116.70	116.70
Vol of Unit Hyd (in):	1.00	1.00	1.00	1.00	1.00
Curve Number:	89.00	89.00	98.00	89.00	89.00
DCIA (%):	0.00	0.00	0.00	0.00	0.00
Time Max (hrs):	60.16	60.17	60.67	60.16	60.16
Flow Max (cfs):	300.56	296.98	35.01	332.24	458.31
Runoff Volume (in):	8.65	8.65	9.76	9.64	13.60
Runoff Volume (cf):	3664211	3354280	793267	4082642	5762505

***					
Basin Name:	AREA2B	AREA2C	AREA3B	AREA3C	AREA1D
Group Name:	BASE	BASE	BASE	BASE	BASE
Node Name:	AREA2B	AREA2C	AREA3B	AREA3C	AREA1D
Hydrograph Type:	UH	UH	UH	UH	UH
Unit Hydrograph:	UH256	UH256	UH256	UH256	UH256
Peaking Factor:	256.00	256.00	256.00	256.00	256.00
Spec Time Inc (min):	3.73	3.73	10.00	10.00	4.27
Comp Time Inc (min):	3.73	3.73	10.00	10.00	4.27
Rainfall File:	SFWMD72	SFWMD72	SFWMD72	SFWMD72	FLMOD
Rainfall Amount (in):	11.00	15.00	11.00	15.00	8.00
Storm Duration (hr):	72.00	72.00	72.00	72.00	24.00
Status:	ONSITE	ONSITE	ONSITE	ONSITE	ONSITE
Time of Conc. (min):	28.00	28.00	75.00	75.00	32.00
Lag Time (hr):	0.00	0.00	0.00	0.00	0.00
Area (acres):	106.80	106.80	106.80	22.40	116.70
Vol of Unit Hyd (in):	1.00	1.00	1.00	1.00	1.00
Curve Number:	89.00	89.00	98.00	98.00	89.00
DCIA (%):	0.00	0.00	0.00	0.00	0.00
Time Max (hrs):	60.17	60.17	60.67	60.67	12.30
Flow Max (cfs):	328.24	452.63	183.66	52.55	304.82

ATTACHMENT #4

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [2]
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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Summary - P10 **********

Runoff Volume (in):	9.64	13.61	10.76	14.75	6.68
Runoff Volume (cf):	3737306	5275032	4169593	1199578	2830533

***	10-YR 24HR	10-YR 24HR
Basin Name:	AREA2D	AREA3D
Group Name:	BASE	BASE
Node Name:	AREA2D	AREA3D
Hydrograph Type:	UH	UH
Unit Hydrograph:	UH256	UH256
Peaking Factor:	256.00	256.00
Spec Time Inc (min):	3.73	10.00
Comp Time Inc (min):	3.73	10.00
Rainfall File:	FLMOD	FLMOD
Rainfall Amount (in):	8.00	8.00
Storm Duration (hr):	24.00	24.00
Status:	ONSITE	ONSITE
Time of Conc. (min):	28.00	75.00
Lag Time (hr):	0.00	0.00
Area (acres):	106.80	22.40
Vol of Unit Hyd (in):	1.00	1.00
Curve Number:	89.00	98.00
DCIA (%):	0.00	0.00
Time Max (hrs):	12.26	12.67
Flow Max (cfs):	299.78	37.85
Runoff Volume (in):	6.68	7.76
Runoff Volume (cf):	2590140	630785

$\left(\frac{6.68}{12}\right) * 116.70 \text{ Acre} \times 43560 \frac{\text{ft}^2}{\text{Acre}} = 2.83 \times 10^6 \text{ cf}$

CN 89 = Pasture or range land, poor cond...

- The SCS technique is very useful for determining the total discharge and the peak flow.

CN 98 = Streets

$\frac{10.76}{12} \times 22.4 \times 43560 = 8.75 \times 10^5 \text{ cf}$

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [1]

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
*** Basin: AREA1		Tmax(hrs): 60.16		Qmax(cfs): 300.558		Vmax(in): 8.65		
0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
2.00	0.0448	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
3.00	0.0895	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
4.00	0.1343	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
5.00	0.1790	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
6.00	0.2238	0.0448	0.0004	0.0004	0.00	45	0.025	0.00
7.00	0.2685	0.0448	0.0034	0.0030	0.00	560	0.261	0.00
8.00	0.3133	0.0448	0.0091	0.0058	0.00	2054	0.568	0.00
9.00	0.3580	0.0448	0.0174	0.0083	0.01	4647	0.872	0.00
10.00	0.4028	0.0448	0.0279	0.0105	0.02	8285	1.149	0.00
11.00	0.4475	0.0448	0.0406	0.0126	0.03	12874	1.401	0.00
12.00	0.4923	0.0448	0.0551	0.0145	0.04	18329	1.630	0.00
13.00	0.5371	0.0448	0.0713	0.0162	0.06	24573	1.839	0.00
14.00	0.5818	0.0448	0.0891	0.0178	0.07	31539	2.031	0.00
15.00	0.6266	0.0448	0.1084	0.0193	0.09	39167	2.207	0.00
16.00	0.6713	0.0448	0.1290	0.0206	0.11	47404	2.369	0.00
17.00	0.7161	0.0448	0.1508	0.0218	0.13	56202	2.519	0.00
18.00	0.7608	0.0448	0.1738	0.0230	0.15	65518	2.657	0.00
19.00	0.8056	0.0448	0.1978	0.0240	0.18	75313	2.785	0.00
20.00	0.8503	0.0448	0.2228	0.0250	0.20	85553	2.904	0.00
21.00	0.8951	0.0448	0.2488	0.0259	0.23	96206	3.014	0.00
22.00	0.9398	0.0448	0.2756	0.0268	0.25	107242	3.117	0.00
23.00	0.9846	0.0448	0.3031	0.0276	0.28	118637	3.213	0.00
24.00	1.0294	0.0448	0.3317	0.0286	0.31	130375	3.308	0.00
25.00	1.0742	0.0448	0.3739	0.0422	0.34	144387	4.477	0.00
26.00	1.1391	0.0650	0.4176	0.0437	0.38	161416	4.984	0.00
27.00	1.2041	0.0650	0.4625	0.0449	0.42	179808	5.234	0.00
28.00	1.2691	0.0650	0.5086	0.0461	0.47	198900	5.373	0.00
29.00	1.3341	0.0650	0.5557	0.0471	0.52	218468	5.498	0.00
30.00	1.3991	0.0650	0.6037	0.0480	0.56	238466	5.613	0.00
31.00	1.4641	0.0650	0.6526	0.0489	0.61	258862	5.719	0.00
32.00	1.5291	0.0650	0.7024	0.0497	0.66	279625	5.816	0.00
33.00	1.5941	0.0650	0.7528	0.0505	0.71	300727	5.907	0.00
34.00	1.6590	0.0650	0.8040	0.0512	0.76	322143	5.991	0.00
35.00	1.7240	0.0650	0.8558	0.0518	0.81	343851	6.069	0.00
36.00	1.7890	0.0650	0.9082	0.0524	0.86	365830	6.142	0.00
37.00	1.8540	0.0650	0.9617	0.0535	0.92	388142	6.254	0.00
38.00	1.9197	0.0657	1.0158	0.0541	0.97	410799	6.333	0.00
39.00	1.9853	0.0657	1.0704	0.0546	1.02	433715	6.398	0.00
40.00	2.0510	0.0657	1.1254	0.0550	1.08	456849	6.454	0.00
41.00	2.1166	0.0657	1.1809	0.0555	1.13	480180	6.507	0.00
42.00	2.1823	0.0657	1.2367	0.0559	1.19	503696	6.557	0.00
43.00	2.2479	0.0657	1.2930	0.0563	1.24	527386	6.604	0.00
44.00	2.3136	0.0657	1.3497	0.0566	1.30	551238	6.648	0.00
45.00	2.3792	0.0657	1.4066	0.0570	1.36	575245	6.689	0.00
46.00	2.4449	0.0657	1.4639	0.0573	1.41	599396	6.728	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [2]

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
47.00	2.5105	0.0657	1.5216	0.0576	1.47	623683	6.765	0.00
48.00	2.5762	0.0657	1.5795	0.0579	1.53	648101	6.800	0.00
49.00	2.6418	0.0657	1.6441	0.0646	1.59	673590	7.361	0.00
50.00	2.7148	0.0729	1.7106	0.0664	1.65	700683	7.691	0.00
51.00	2.7893	0.0745	1.7893	0.0788	1.72	730376	8.805	0.00
52.00	2.8772	0.0879	1.8760	0.0867	1.80	763850	9.792	0.00
53.00	2.9732	0.0960	1.9892	0.1132	1.90	803595	12.289	0.00
54.00	3.0981	0.1249	2.1296	0.1404	2.01	853283	15.316	0.00
55.00	3.2520	0.1539	2.2985	0.1689	2.16	914367	18.620	0.00
56.00	3.4359	0.1839	2.4965	0.1980	2.33	987497	22.008	0.00
57.00	3.6497	0.2138	2.7295	0.2331	2.53	1073752	25.912	0.00
58.00	3.8994	0.2497	3.0193	0.2898	2.78	1177793	31.889	0.00
59.00	4.2080	0.3086	3.4159	0.3966	3.10	1312047	42.696	0.00
60.00	4.6233	0.4154	6.1235	2.7076	4.37	1850406	256.392	0.00
61.00	7.4716	2.8482	6.9669	0.8434	6.13	2595075	157.313	0.00
62.00	8.2867	0.8151	7.3358	0.3690	7.13	3022045	79.892	0.00
63.00	8.6612	0.3745	7.5675	0.2316	7.62	3229350	35.277	0.00
64.00	8.8960	0.2348	7.7848	0.2173	7.89	3341496	27.026	0.00
65.00	9.1168	0.2208	7.9149	0.1301	8.08	3423491	18.527	0.00
66.00	9.2488	0.1320	8.0459	0.1310	8.23	3485810	16.094	0.00
67.00	9.3817	0.1329	8.1769	0.1310	8.36	3542533	15.419	0.00
68.00	9.5146	0.1329	8.3073	0.1304	8.49	3598009	15.401	0.00
69.00	9.6473	0.1327	8.3945	0.0873	8.61	3646963	11.796	0.00
70.00	9.7352	0.0879	8.4813	0.0868	8.70	3687222	10.570	0.00
71.00	9.8231	0.0879	8.5686	0.0873	8.79	3724712	10.258	0.00
72.00	9.9116	0.0884	8.6526	0.0840	8.88	3761536	10.200	0.00

*** Basin: AREA2 Tmax(hrs): 60.17 Qmax(cfs): 296.984 Vmax(in): 8.65

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
2.00	0.0448	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
3.00	0.0895	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
4.00	0.1343	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
5.00	0.1790	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
6.00	0.2238	0.0448	0.0004	0.0004	0.00	51	0.028	0.00
7.00	0.2685	0.0448	0.0034	0.0030	0.00	571	0.261	0.00
8.00	0.3133	0.0448	0.0091	0.0058	0.01	2033	0.551	0.00
9.00	0.3580	0.0448	0.0174	0.0083	0.01	4513	0.827	0.00
10.00	0.4028	0.0448	0.0279	0.0105	0.02	7942	1.078	0.00
11.00	0.4475	0.0448	0.0406	0.0126	0.03	12232	1.306	0.00
12.00	0.4923	0.0448	0.0551	0.0145	0.04	17306	1.513	0.00
13.00	0.5371	0.0448	0.0713	0.0162	0.06	23095	1.703	0.00
14.00	0.5818	0.0448	0.0891	0.0178	0.08	29539	1.877	0.00
15.00	0.6266	0.0448	0.1084	0.0193	0.09	36583	2.036	0.00
16.00	0.6713	0.0448	0.1290	0.0206	0.11	44179	2.184	0.00
17.00	0.7161	0.0448	0.1508	0.0218	0.13	52284	2.319	0.00
18.00	0.7608	0.0448	0.1738	0.0230	0.16	60859	2.445	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [3]

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
19.00	0.8056	0.0448	0.1978	0.0240	0.18	69869	2.561	0.00
20.00	0.8503	0.0448	0.2228	0.0250	0.20	79282	2.669	0.00
21.00	0.8951	0.0448	0.2488	0.0259	0.23	89070	2.769	0.00
22.00	0.9398	0.0448	0.2756	0.0268	0.26	99207	2.863	0.00
23.00	0.9846	0.0448	0.3031	0.0276	0.28	109669	2.950	0.00
24.00	1.0294	0.0448	0.3317	0.0285	0.31	120442	3.035	0.00
25.00	1.0742	0.0448	0.3739	0.0422	0.34	133435	4.183	0.00
26.00	1.1391	0.0650	0.4176	0.0437	0.39	149283	4.621	0.00
27.00	1.2041	0.0650	0.4625	0.0449	0.43	166253	4.807	0.00
28.00	1.2691	0.0650	0.5086	0.0461	0.47	183779	4.930	0.00
29.00	1.3341	0.0650	0.5557	0.0471	0.52	201731	5.043	0.00
30.00	1.3991	0.0650	0.6037	0.0480	0.57	220075	5.147	0.00
31.00	1.4641	0.0650	0.6526	0.0489	0.62	238778	5.244	0.00
32.00	1.5291	0.0650	0.7024	0.0497	0.67	257815	5.332	0.00
33.00	1.5941	0.0650	0.7528	0.0505	0.71	277159	5.414	0.00
34.00	1.6590	0.0650	0.8040	0.0512	0.77	296788	5.491	0.00
35.00	1.7240	0.0650	0.8558	0.0518	0.82	316683	5.562	0.00
36.00	1.7890	0.0650	0.9082	0.0524	0.87	336823	5.628	0.00
37.00	1.8540	0.0650	0.9618	0.0535	0.92	357273	5.733	0.00
38.00	1.9197	0.0657	1.0158	0.0541	0.98	378039	5.804	0.00
39.00	1.9853	0.0657	1.0704	0.0546	1.03	399036	5.861	0.00
40.00	2.0510	0.0657	1.1254	0.0550	1.08	420228	5.912	0.00
41.00	2.1166	0.0657	1.1809	0.0555	1.14	441599	5.960	0.00
42.00	2.1823	0.0657	1.2368	0.0559	1.19	463138	6.006	0.00
43.00	2.2479	0.0657	1.2930	0.0563	1.25	484834	6.048	0.00
44.00	2.3136	0.0657	1.3497	0.0566	1.31	506679	6.088	0.00
45.00	2.3792	0.0657	1.4066	0.0570	1.36	528664	6.126	0.00
46.00	2.4449	0.0657	1.4640	0.0573	1.42	550780	6.161	0.00
47.00	2.5105	0.0657	1.5216	0.0576	1.48	573020	6.195	0.00
48.00	2.5762	0.0657	1.5796	0.0580	1.54	595382	6.228	0.00
49.00	2.6418	0.0657	1.6441	0.0646	1.60	618791	6.777	0.00
50.00	2.7148	0.0729	1.7107	0.0665	1.66	643725	7.075	0.00
51.00	2.7893	0.0745	1.7894	0.0787	1.73	671107	8.137	0.00
52.00	2.8772	0.0879	1.8760	0.0866	1.81	702045	9.050	0.00
53.00	2.9732	0.0960	1.9891	0.1131	1.91	738908	11.429	0.00
54.00	3.0981	0.1249	2.1293	0.1403	2.03	785161	14.268	0.00
55.00	3.2520	0.1539	2.2981	0.1688	2.17	841988	17.303	0.00
56.00	3.4359	0.1839	2.4960	0.1979	2.35	909872	20.410	0.00
57.00	3.6497	0.2138	2.7291	0.2331	2.55	989850	24.022	0.00
58.00	3.8994	0.2497	3.0192	0.2901	2.80	1086621	29.740	0.00
59.00	4.2080	0.3086	3.4148	0.3956	3.13	1212688	40.297	0.00
60.00	4.6233	0.4154	6.1264	2.7115	4.54	1761164	264.412	0.00
61.00	7.4716	2.8482	6.9664	0.8400	6.42	2487564	139.143	0.00
62.00	8.2867	0.8151	7.3352	0.3688	7.36	2851567	63.082	0.00
63.00	8.6612	0.3745	7.5675	0.2323	7.78	3017704	29.217	0.00
64.00	8.8960	0.2348	7.7837	0.2162	8.03	3113718	24.125	0.00
65.00	9.1168	0.2208	7.9149	0.1313	8.22	3186655	16.396	0.00

66.00	9.2488	0.1320	8.0459	0.1310	8.36	3242131	14.424	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [4]
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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
67.00	9.3817	0.1329	8.1769	0.1310	8.50	3293471	14.098	0.00
68.00	9.5146	0.1329	8.3075	0.1306	8.63	3344224	14.098	0.00
69.00	9.6473	0.1327	8.3945	0.0870	8.74	3388573	10.540	0.00
70.00	9.7352	0.0879	8.4813	0.0868	8.83	3424673	9.516	0.00
71.00	9.8231	0.0879	8.5686	0.0873	8.92	3458690	9.382	0.00
72.00	9.9116	0.0884	8.6550	0.0864	9.01	3492455	9.376	0.00

*** Basin: AREA3 Tmax(hrs): 60.67 Qmax(cfs): 35.012 Vmax(in): 9.76

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0001	0.0001	0.00	0	0.000	0.00
2.00	0.0448	0.0448	0.0094	0.0093	0.00	97	0.054	0.00
3.00	0.0895	0.0448	0.0293	0.0200	0.01	565	0.206	0.00
4.00	0.1343	0.0448	0.0558	0.0265	0.02	1591	0.364	0.00
5.00	0.1790	0.0448	0.0865	0.0307	0.04	3143	0.498	0.00
6.00	0.2238	0.0448	0.1201	0.0336	0.06	5136	0.609	0.00
7.00	0.2685	0.0448	0.1558	0.0357	0.09	7486	0.697	0.00
8.00	0.3133	0.0448	0.1930	0.0373	0.12	10113	0.763	0.00
9.00	0.3580	0.0448	0.2315	0.0384	0.16	12947	0.811	0.00
10.00	0.4028	0.0448	0.2708	0.0394	0.20	15932	0.847	0.00
11.00	0.4475	0.0448	0.3109	0.0401	0.23	19027	0.873	0.00
12.00	0.4923	0.0448	0.3516	0.0407	0.27	22207	0.893	0.00
13.00	0.5371	0.0448	0.3928	0.0412	0.31	25451	0.909	0.00
14.00	0.5818	0.0448	0.4344	0.0416	0.35	28748	0.922	0.00
15.00	0.6266	0.0448	0.4763	0.0419	0.39	32088	0.933	0.00
16.00	0.6713	0.0448	0.5185	0.0422	0.44	35462	0.942	0.00
17.00	0.7161	0.0448	0.5610	0.0425	0.48	38865	0.949	0.00
18.00	0.7608	0.0448	0.6037	0.0427	0.52	42293	0.955	0.00
19.00	0.8056	0.0448	0.6465	0.0429	0.56	45741	0.961	0.00
20.00	0.8503	0.0448	0.6895	0.0430	0.61	49207	0.965	0.00
21.00	0.8951	0.0448	0.7327	0.0432	0.65	52689	0.969	0.00
22.00	0.9398	0.0448	0.7760	0.0433	0.69	56184	0.973	0.00
23.00	0.9846	0.0448	0.8194	0.0434	0.73	59691	0.976	0.00
24.00	1.0294	0.0448	0.8629	0.0435	0.78	63208	0.978	0.00
25.00	1.0742	0.0448	0.9262	0.0633	0.82	66987	1.121	0.00
26.00	1.1391	0.0650	0.9897	0.0635	0.88	71278	1.263	0.00
27.00	1.2041	0.0650	1.0533	0.0636	0.93	75959	1.338	0.00
28.00	1.2691	0.0650	1.1170	0.0637	0.99	80856	1.382	0.00
29.00	1.3341	0.0650	1.1808	0.0638	1.06	85889	1.414	0.00
30.00	1.3991	0.0650	1.2448	0.0639	1.12	91011	1.432	0.00
31.00	1.4641	0.0650	1.3088	0.0640	1.18	96183	1.441	0.00
32.00	1.5291	0.0650	1.3729	0.0641	1.25	101377	1.444	0.00
33.00	1.5941	0.0650	1.4370	0.0641	1.31	106579	1.446	0.00
34.00	1.6590	0.0650	1.5012	0.0642	1.37	111786	1.447	0.00
35.00	1.7240	0.0650	1.5654	0.0643	1.44	117000	1.449	0.00
36.00	1.7890	0.0650	1.6297	0.0643	1.50	122218	1.450	0.00

37.00	1.8540	0.0650	1.6948	0.0650	1.57	127449	1.456	0.00
38.00	1.9197	0.0657	1.7598	0.0650	1.63	132700	1.462	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [5]

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
39.00	1.9853	0.0657	1.8249	0.0651	1.70	137968	1.465	0.00
40.00	2.0510	0.0657	1.8900	0.0651	1.76	143246	1.467	0.00
41.00	2.1166	0.0657	1.9551	0.0651	1.83	148531	1.469	0.00
42.00	2.1823	0.0657	2.0203	0.0652	1.89	153822	1.470	0.00
43.00	2.2479	0.0657	2.0855	0.0652	1.96	159116	1.471	0.00
44.00	2.3136	0.0657	2.1507	0.0652	2.02	164414	1.472	0.00
45.00	2.3792	0.0657	2.2160	0.0652	2.09	169713	1.472	0.00
46.00	2.4449	0.0657	2.2812	0.0653	2.15	175014	1.473	0.00
47.00	2.5105	0.0657	2.3465	0.0653	2.22	180317	1.473	0.00
48.00	2.5762	0.0657	2.4118	0.0653	2.28	185622	1.474	0.00
49.00	2.6418	0.0657	2.4844	0.0725	2.35	191021	1.525	0.00
50.00	2.7148	0.0729	2.5585	0.0742	2.42	196625	1.588	0.00
51.00	2.7893	0.0745	2.6460	0.0875	2.49	202582	1.721	0.00
52.00	2.8772	0.0879	2.7416	0.0956	2.57	209088	1.894	0.00
53.00	2.9732	0.0960	2.8660	0.1244	2.66	216489	2.218	0.00
54.00	3.0981	0.1249	3.0194	0.1533	2.77	225329	2.693	0.00
55.00	3.2520	0.1539	3.2026	0.1832	2.90	236035	3.255	0.00
56.00	3.4359	0.1839	3.4158	0.2132	3.06	248857	3.868	0.00
57.00	3.6497	0.2138	3.6649	0.2491	3.25	264024	4.558	0.00
58.00	3.8994	0.2497	3.9727	0.3079	3.47	282000	5.429	0.00
59.00	4.2080	0.3086	4.3873	0.4146	3.74	303899	6.738	0.00
60.00	4.6233	0.4154	7.2324	2.8451	4.30	349345	18.510	0.00
61.00	7.4716	2.8482	8.0468	0.8144	5.42	440904	32.356	0.00
62.00	8.2867	0.8151	8.4210	0.3742	6.61	537539	21.330	0.00
63.00	8.6612	0.3745	8.6558	0.2347	7.40	602031	14.499	0.00
64.00	8.8960	0.2348	8.8763	0.2206	7.97	648226	11.165	0.00
65.00	9.1168	0.2208	9.0084	0.1320	8.40	682850	8.070	0.00
66.00	9.2488	0.1320	9.1412	0.1328	8.70	707302	5.514	0.00
67.00	9.3817	0.1329	9.2740	0.1328	8.91	724338	3.950	0.00
68.00	9.5146	0.1329	9.4067	0.1327	9.07	737397	3.305	0.00
69.00	9.6473	0.1327	9.4945	0.0879	9.20	748372	2.792	0.00
70.00	9.7352	0.0879	9.5824	0.0879	9.32	757711	2.396	0.00
71.00	9.8231	0.0879	9.6708	0.0884	9.42	765994	2.205	0.00
72.00	9.9116	0.0884	9.7591	0.0882	9.52	773762	2.110	0.00

*** Basin: AREA1B Tmax(hrs): 60.16 Qmax(cfs): 332.242 Vmax(in): 9.64

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
2.00	0.0448	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
3.00	0.0895	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
4.00	0.1343	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
5.00	0.1790	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
6.00	0.2238	0.0448	0.0018	0.0018	0.00	273	0.152	0.00
7.00	0.2685	0.0448	0.0071	0.0053	0.00	1438	0.496	0.00

8.00	0.3133	0.0448	0.0156	0.0084	0.01	3889	0.866	0.00
9.00	0.3580	0.0448	0.0268	0.0112	0.02	7624	1.209	0.00
10.00	0.4028	0.0448	0.0406	0.0138	0.03	12531	1.517	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [6]
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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
11.00	0.4475	0.0448	0.0566	0.0160	0.04	18495	1.796	0.00
12.00	0.4923	0.0448	0.0747	0.0181	0.06	25413	2.048	0.00
13.00	0.5371	0.0448	0.0947	0.0200	0.08	33196	2.277	0.00
14.00	0.5818	0.0448	0.1164	0.0217	0.10	41767	2.485	0.00
15.00	0.6266	0.0448	0.1397	0.0233	0.12	51056	2.675	0.00
16.00	0.6713	0.0448	0.1644	0.0247	0.14	61001	2.850	0.00
17.00	0.7161	0.0448	0.1905	0.0260	0.17	71549	3.010	0.00
18.00	0.7608	0.0448	0.2177	0.0273	0.20	82651	3.158	0.00
19.00	0.8056	0.0448	0.2461	0.0284	0.22	94264	3.294	0.00
20.00	0.8503	0.0448	0.2756	0.0294	0.25	106347	3.419	0.00
21.00	0.8951	0.0448	0.3059	0.0304	0.28	118866	3.536	0.00
22.00	0.9398	0.0448	0.3372	0.0313	0.31	131790	3.644	0.00
23.00	0.9846	0.0448	0.3693	0.0321	0.34	145089	3.744	0.00
24.00	1.0294	0.0448	0.4025	0.0332	0.37	158748	3.844	0.00
25.00	1.0742	0.0448	0.4513	0.0488	0.41	175001	5.186	0.00
26.00	1.1391	0.0650	0.5017	0.0504	0.46	194694	5.755	0.00
27.00	1.2041	0.0650	0.5534	0.0517	0.51	215901	6.027	0.00
28.00	1.2691	0.0650	0.6063	0.0528	0.56	237854	6.170	0.00
29.00	1.3341	0.0650	0.6602	0.0539	0.61	260295	6.298	0.00
30.00	1.3991	0.0650	0.7150	0.0549	0.67	283178	6.415	0.00
31.00	1.4641	0.0650	0.7708	0.0558	0.72	306466	6.523	0.00
32.00	1.5291	0.0650	0.8274	0.0566	0.78	330127	6.622	0.00
33.00	1.5941	0.0650	0.8847	0.0573	0.84	354132	6.714	0.00
34.00	1.6590	0.0650	0.9427	0.0580	0.89	378454	6.799	0.00
35.00	1.7240	0.0650	1.0014	0.0587	0.95	403071	6.877	0.00
36.00	1.7890	0.0650	1.0607	0.0593	1.01	427960	6.950	0.00
37.00	1.8540	0.0650	1.1212	0.0605	1.07	453193	7.068	0.00
38.00	1.9197	0.0657	1.1822	0.0610	1.13	478785	7.150	0.00
39.00	1.9853	0.0657	1.2437	0.0615	1.19	504641	7.215	0.00
40.00	2.0510	0.0657	1.3057	0.0620	1.25	530715	7.271	0.00
41.00	2.1166	0.0657	1.3681	0.0624	1.31	556985	7.324	0.00
42.00	2.1823	0.0657	1.4309	0.0628	1.38	583438	7.373	0.00
43.00	2.2479	0.0657	1.4941	0.0632	1.44	610063	7.419	0.00
44.00	2.3136	0.0657	1.5577	0.0636	1.50	636850	7.462	0.00
45.00	2.3792	0.0657	1.6216	0.0639	1.57	663788	7.503	0.00
46.00	2.4449	0.0657	1.6858	0.0642	1.63	690869	7.542	0.00
47.00	2.5105	0.0657	1.7503	0.0645	1.70	718085	7.578	0.00
48.00	2.5762	0.0657	1.8151	0.0648	1.76	745428	7.612	0.00
49.00	2.6418	0.0657	1.8874	0.0723	1.83	773953	8.235	0.00
50.00	2.7148	0.0729	1.9617	0.0743	1.90	804254	8.599	0.00
51.00	2.7893	0.0745	2.0497	0.0880	1.98	837441	9.838	0.00
52.00	2.8772	0.0879	2.1464	0.0968	2.07	874829	10.933	0.00
53.00	2.9732	0.0960	2.2727	0.1263	2.17	919189	13.711	0.00
54.00	3.0981	0.1249	2.4292	0.1565	2.30	974601	17.074	0.00

55.00	3.2520	0.1539	2.6173	0.1881	2.46	1042663	20.738	0.00
56.00	3.4359	0.1839	2.8375	0.2202	2.65	1124068	24.488	0.00
57.00	3.6497	0.2138	3.0965	0.2590	2.88	1219990	28.803	0.00
58.00	3.8994	0.2497	3.4182	0.3217	3.15	1335572	35.409	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [7]

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
59.00	4.2080	0.3086	3.8579	0.4398	3.50	1484551	47.357	0.00
60.00	4.6233	0.4154	6.8513	2.9933	4.91	2080197	283.558	0.00
61.00	7.4716	2.8482	7.7819	0.9306	6.85	2903375	173.763	0.00
62.00	8.2867	0.8151	8.1889	0.4070	7.97	3374895	88.192	0.00
63.00	8.6612	0.3745	8.4443	0.2554	8.51	3603680	38.910	0.00
64.00	8.8960	0.2348	8.6839	0.2396	8.80	3727364	29.803	0.00
65.00	9.1168	0.2208	8.8274	0.1435	9.01	3817782	20.429	0.00
66.00	9.2488	0.1320	8.9718	0.1444	9.17	3886495	17.745	0.00
67.00	9.3817	0.1329	9.1162	0.1444	9.32	3949037	17.000	0.00
68.00	9.5146	0.1329	9.2600	0.1437	9.47	4010198	16.978	0.00
69.00	9.6473	0.1327	9.3562	0.0962	9.59	4064166	13.003	0.00
70.00	9.7352	0.0879	9.4518	0.0957	9.70	4108547	11.653	0.00
71.00	9.8231	0.0879	9.5480	0.0962	9.80	4149874	11.307	0.00
72.00	9.9116	0.0884	9.6407	0.0926	9.89	4190465	11.243	0.00

*** Basin: AREA1C Tmax(hrs): 60.16 Qmax(cfs): 458.310 Vmax(in): 13.60

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
2.00	0.0448	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
3.00	0.0895	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
4.00	0.1343	0.0448	0.0004	0.0004	0.00	33	0.018	0.00
5.00	0.1790	0.0448	0.0059	0.0055	0.00	921	0.475	0.00
6.00	0.2238	0.0448	0.0174	0.0115	0.01	3788	1.118	0.00
7.00	0.2685	0.0448	0.0340	0.0166	0.02	8942	1.745	0.00
8.00	0.3133	0.0448	0.0551	0.0211	0.04	16217	2.296	0.00
9.00	0.3580	0.0448	0.0800	0.0249	0.06	25347	2.776	0.00
10.00	0.4028	0.0448	0.1084	0.0284	0.09	36098	3.197	0.00
11.00	0.4475	0.0448	0.1397	0.0314	0.11	48273	3.568	0.00
12.00	0.4923	0.0448	0.1738	0.0340	0.15	61708	3.896	0.00
13.00	0.5371	0.0448	0.2102	0.0364	0.18	76260	4.189	0.00
14.00	0.5818	0.0448	0.2488	0.0386	0.22	91810	4.450	0.00
15.00	0.6266	0.0448	0.2893	0.0405	0.26	108254	4.685	0.00
16.00	0.6713	0.0448	0.3315	0.0422	0.30	125501	4.897	0.00
17.00	0.7161	0.0448	0.3753	0.0438	0.34	143474	5.088	0.00
18.00	0.7608	0.0448	0.4205	0.0452	0.38	162104	5.262	0.00
19.00	0.8056	0.0448	0.4670	0.0465	0.43	181330	5.420	0.00
20.00	0.8503	0.0448	0.5147	0.0477	0.47	201101	5.564	0.00
21.00	0.8951	0.0448	0.5635	0.0488	0.52	221368	5.696	0.00
22.00	0.9398	0.0448	0.6133	0.0498	0.57	242091	5.817	0.00
23.00	0.9846	0.0448	0.6640	0.0507	0.62	263232	5.928	0.00
24.00	1.0294	0.0448	0.7160	0.0520	0.67	284775	6.040	0.00
25.00	1.0742	0.0448	0.7919	0.0759	0.73	310187	8.079	0.00

26.00	1.1391	0.0650	0.8696	0.0777	0.80	340736	8.893	0.00
27.00	1.2041	0.0650	0.9487	0.0791	0.88	373378	9.242	0.00
28.00	1.2691	0.0650	1.0289	0.0803	0.96	406920	9.393	0.00
29.00	1.3341	0.0650	1.1103	0.0813	1.04	440974	9.526	0.00
30.00	1.3991	0.0650	1.1926	0.0823	1.12	475482	9.646	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [8]
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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
31.00	1.4641	0.0650	1.2759	0.0832	1.20	510403	9.755	0.00
32.00	1.5291	0.0650	1.3599	0.0841	1.29	545701	9.855	0.00
33.00	1.5941	0.0650	1.4447	0.0848	1.37	581343	9.946	0.00
34.00	1.6590	0.0650	1.5302	0.0855	1.46	617301	10.030	0.00
35.00	1.7240	0.0650	1.6164	0.0861	1.54	653548	10.107	0.00
36.00	1.7890	0.0650	1.7031	0.0867	1.63	690061	10.178	0.00
37.00	1.8540	0.0650	1.7913	0.0882	1.72	726953	10.317	0.00
38.00	1.9197	0.0657	1.8799	0.0887	1.80	764249	10.403	0.00
39.00	1.9853	0.0657	1.9691	0.0892	1.89	801818	10.468	0.00
40.00	2.0510	0.0657	2.0587	0.0896	1.98	839598	10.521	0.00
41.00	2.1166	0.0657	2.1487	0.0900	2.07	877564	10.571	0.00
42.00	2.1823	0.0657	2.2391	0.0904	2.16	915703	10.617	0.00
43.00	2.2479	0.0657	2.3298	0.0907	2.25	954002	10.660	0.00
44.00	2.3136	0.0657	2.4209	0.0911	2.34	992451	10.700	0.00
45.00	2.3792	0.0657	2.5123	0.0914	2.43	1031041	10.738	0.00
46.00	2.4449	0.0657	2.6040	0.0917	2.53	1069762	10.773	0.00
47.00	2.5105	0.0657	2.6959	0.0920	2.62	1108606	10.807	0.00
48.00	2.5762	0.0657	2.7882	0.0922	2.71	1147566	10.838	0.00
49.00	2.6418	0.0657	2.8909	0.1027	2.80	1188144	11.705	0.00
50.00	2.7148	0.0729	2.9962	0.1054	2.91	1231179	12.203	0.00
51.00	2.7893	0.0745	3.1208	0.1246	3.02	1278234	13.938	0.00
52.00	2.8772	0.0879	3.2576	0.1368	3.14	1331157	15.464	0.00
53.00	2.9732	0.0960	3.4358	0.1782	3.29	1393829	19.354	0.00
54.00	3.0981	0.1249	3.6560	0.2203	3.47	1471957	24.050	0.00
55.00	3.2520	0.1539	3.9202	0.2641	3.70	1567704	29.143	0.00
56.00	3.4359	0.1839	4.2287	0.3085	3.97	1681951	34.328	0.00
57.00	3.6497	0.2138	4.5905	0.3619	4.29	1816237	40.276	0.00
58.00	3.8994	0.2497	5.0389	0.4484	4.67	1977627	49.385	0.00
59.00	4.2080	0.3086	5.6501	0.6112	5.16	2185079	65.866	0.00
60.00	4.6233	0.4154	9.7804	4.1303	7.10	3008537	391.611	0.00
61.00	7.4716	2.8482	11.0587	1.2782	9.78	4144098	239.256	0.00
62.00	8.2867	0.8151	11.6172	0.5585	11.31	4793014	121.253	0.00
63.00	8.6612	0.3745	11.9675	0.3504	12.06	5107376	53.393	0.00
64.00	8.8960	0.2348	12.2962	0.3286	12.46	5277059	40.876	0.00
65.00	9.1168	0.2208	12.4929	0.1967	12.75	5401060	28.014	0.00
66.00	9.2488	0.1320	12.6908	0.1980	12.97	5495277	24.328	0.00
67.00	9.3817	0.1329	12.8888	0.1980	13.17	5581014	23.304	0.00
68.00	9.5146	0.1329	13.0858	0.1970	13.37	5664849	23.271	0.00
69.00	9.6473	0.1327	13.2177	0.1318	13.55	5738815	17.821	0.00
70.00	9.7352	0.0879	13.3487	0.1311	13.69	5799636	15.968	0.00
71.00	9.8231	0.0879	13.4806	0.1318	13.82	5856267	15.494	0.00
72.00	9.9116	0.0884	13.6075	0.1269	13.96	5911884	15.405	0.00

*** Basin: AREA2B Tmax(hrs): 60.17 Qmax(cfs): 328.243 Vmax(in): 9.64

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
2.00	0.0448	0.0448	0.0000	0.0000	0.00	0	0.000	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [9]
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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
3.00	0.0895	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
4.00	0.1343	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
5.00	0.1790	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
6.00	0.2238	0.0448	0.0018	0.0018	0.00	282	0.157	0.00
7.00	0.2685	0.0448	0.0071	0.0053	0.00	1441	0.487	0.00
8.00	0.3133	0.0448	0.0156	0.0084	0.01	3809	0.829	0.00
9.00	0.3580	0.0448	0.0268	0.0112	0.02	7350	1.139	0.00
10.00	0.4028	0.0448	0.0406	0.0138	0.03	11952	1.418	0.00
11.00	0.4475	0.0448	0.0566	0.0160	0.05	17510	1.670	0.00
12.00	0.4923	0.0448	0.0747	0.0181	0.06	23932	1.898	0.00
13.00	0.5371	0.0448	0.0947	0.0200	0.08	31137	2.105	0.00
14.00	0.5818	0.0448	0.1164	0.0217	0.10	39055	2.294	0.00
15.00	0.6266	0.0448	0.1397	0.0233	0.12	47624	2.467	0.00
16.00	0.6713	0.0448	0.1644	0.0247	0.15	56788	2.625	0.00
17.00	0.7161	0.0448	0.1905	0.0260	0.17	66499	2.770	0.00
18.00	0.7608	0.0448	0.2177	0.0273	0.20	76712	2.904	0.00
19.00	0.8056	0.0448	0.2461	0.0284	0.23	87387	3.027	0.00
20.00	0.8503	0.0448	0.2756	0.0294	0.25	98491	3.141	0.00
21.00	0.8951	0.0448	0.3059	0.0304	0.28	109990	3.247	0.00
22.00	0.9398	0.0448	0.3372	0.0313	0.31	121855	3.345	0.00
23.00	0.9846	0.0448	0.3693	0.0321	0.35	134062	3.436	0.00
24.00	1.0294	0.0448	0.4025	0.0331	0.38	146594	3.526	0.00
25.00	1.0742	0.0448	0.4513	0.0489	0.42	161661	4.844	0.00
26.00	1.1391	0.0650	0.5018	0.0504	0.46	179983	5.335	0.00
27.00	1.2041	0.0650	0.5534	0.0517	0.51	199544	5.533	0.00
28.00	1.2691	0.0650	0.6063	0.0528	0.57	219691	5.660	0.00
29.00	1.3341	0.0650	0.6602	0.0539	0.62	240274	5.776	0.00
30.00	1.3991	0.0650	0.7151	0.0549	0.67	261258	5.882	0.00
31.00	1.4641	0.0650	0.7708	0.0558	0.73	282609	5.980	0.00
32.00	1.5291	0.0650	0.8274	0.0566	0.78	304299	6.070	0.00
33.00	1.5941	0.0650	0.8847	0.0573	0.84	326300	6.153	0.00
34.00	1.6590	0.0650	0.9428	0.0580	0.90	348589	6.230	0.00
35.00	1.7240	0.0650	1.0014	0.0587	0.96	371145	6.301	0.00
36.00	1.7890	0.0650	1.0607	0.0593	1.02	393950	6.368	0.00
37.00	1.8540	0.0650	1.1212	0.0605	1.08	417073	6.479	0.00
38.00	1.9197	0.0657	1.1822	0.0610	1.14	440527	6.551	0.00
39.00	1.9853	0.0657	1.2437	0.0615	1.20	464215	6.608	0.00
40.00	2.0510	0.0657	1.3057	0.0620	1.26	488097	6.660	0.00
41.00	2.1166	0.0657	1.3681	0.0624	1.32	512158	6.707	0.00
42.00	2.1823	0.0657	1.4309	0.0628	1.38	536385	6.752	0.00
43.00	2.2479	0.0657	1.4941	0.0632	1.45	560768	6.794	0.00

44.00	2.3136	0.0657	1.5577	0.0636	1.51	585298	6.834	0.00
45.00	2.3792	0.0657	1.6216	0.0639	1.57	609965	6.871	0.00
46.00	2.4449	0.0657	1.6858	0.0642	1.64	634763	6.906	0.00
47.00	2.5105	0.0657	1.7503	0.0645	1.70	659683	6.939	0.00
48.00	2.5762	0.0657	1.8152	0.0649	1.77	684722	6.972	0.00
49.00	2.6418	0.0657	1.8874	0.0722	1.83	710918	7.581	0.00
50.00	2.7148	0.0729	1.9618	0.0744	1.91	738802	7.910	0.00

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
51.00	2.7893	0.0745	2.0497	0.0879	1.98	769405	9.092	0.00
52.00	2.8772	0.0879	2.1464	0.0967	2.07	803959	10.105	0.00
53.00	2.9732	0.0960	2.2726	0.1262	2.18	845099	12.751	0.00
54.00	3.0981	0.1249	2.4289	0.1563	2.31	896677	15.904	0.00
55.00	3.2520	0.1539	2.6168	0.1879	2.48	959990	19.270	0.00
56.00	3.4359	0.1839	2.8370	0.2201	2.67	1035550	22.708	0.00
57.00	3.6497	0.2138	3.0960	0.2590	2.90	1124483	26.699	0.00
58.00	3.8994	0.2497	3.4180	0.3220	3.18	1231978	33.020	0.00
59.00	4.2080	0.3086	3.8567	0.4387	3.54	1371859	44.691	0.00
60.00	4.6233	0.4154	6.8545	2.9977	5.10	1978604	292.390	0.00
61.00	7.4716	2.8482	7.7814	0.9269	7.17	2781529	153.680	0.00
62.00	8.2867	0.8151	8.1881	0.4067	8.21	3183466	69.618	0.00
63.00	8.6612	0.3745	8.4444	0.2562	8.68	3366781	32.223	0.00
64.00	8.8960	0.2348	8.6827	0.2384	8.96	3472669	26.603	0.00
65.00	9.1168	0.2208	8.8275	0.1447	9.16	3553097	18.079	0.00
66.00	9.2488	0.1320	8.9719	0.1444	9.32	3614266	15.903	0.00
67.00	9.3817	0.1329	9.1163	0.1444	9.47	3670870	15.543	0.00
68.00	9.5146	0.1329	9.2603	0.1440	9.61	3726824	15.542	0.00
69.00	9.6473	0.1327	9.3562	0.0959	9.74	3775715	11.619	0.00
70.00	9.7352	0.0879	9.4519	0.0956	9.84	3815512	10.490	0.00
71.00	9.8231	0.0879	9.5481	0.0962	9.94	3853010	10.342	0.00
72.00	9.9116	0.0884	9.6433	0.0952	10.03	3890230	10.335	0.00

*** Basin: AREA2C Tmax(hrs): 60.17 Qmax(cfs): 452.630 Vmax(in): 13.61

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
2.00	0.0448	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
3.00	0.0895	0.0448	0.0000	0.0000	0.00	0	0.000	0.00
4.00	0.1343	0.0448	0.0004	0.0004	0.00	39	0.021	0.00
5.00	0.1790	0.0448	0.0059	0.0055	0.00	938	0.478	0.00
6.00	0.2238	0.0448	0.0174	0.0115	0.01	3756	1.087	0.00
7.00	0.2685	0.0448	0.0340	0.0166	0.02	8695	1.657	0.00
8.00	0.3133	0.0448	0.0551	0.0211	0.04	15554	2.153	0.00
9.00	0.3580	0.0448	0.0800	0.0249	0.06	24084	2.586	0.00
10.00	0.4028	0.0448	0.1084	0.0284	0.09	34076	2.965	0.00
11.00	0.4475	0.0448	0.1397	0.0314	0.12	45354	3.300	0.00
12.00	0.4923	0.0448	0.1738	0.0340	0.15	57768	3.597	0.00
13.00	0.5371	0.0448	0.2102	0.0364	0.18	71191	3.861	0.00
14.00	0.5818	0.0448	0.2488	0.0386	0.22	85517	4.097	0.00

15.00	0.6266	0.0448	0.2893	0.0405	0.26	100650	4.310	0.00
16.00	0.6713	0.0448	0.3315	0.0422	0.30	116510	4.501	0.00
17.00	0.7161	0.0448	0.3753	0.0438	0.34	133027	4.675	0.00
18.00	0.7608	0.0448	0.4205	0.0452	0.39	150139	4.832	0.00
19.00	0.8056	0.0448	0.4670	0.0465	0.43	167791	4.975	0.00
20.00	0.8503	0.0448	0.5147	0.0477	0.48	185936	5.106	0.00
21.00	0.8951	0.0448	0.5635	0.0488	0.53	204531	5.225	0.00
22.00	0.9398	0.0448	0.6133	0.0498	0.58	223540	5.335	0.00

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
23.00	0.9846	0.0448	0.6640	0.0507	0.63	242928	5.436	0.00
24.00	1.0294	0.0448	0.7159	0.0519	0.68	262677	5.536	0.00
25.00	1.0742	0.0448	0.7919	0.0760	0.74	286216	7.541	0.00
26.00	1.1391	0.0650	0.8696	0.0777	0.81	314618	8.238	0.00
27.00	1.2041	0.0650	0.9487	0.0791	0.89	344706	8.477	0.00
28.00	1.2691	0.0650	1.0289	0.0803	0.97	375463	8.610	0.00
29.00	1.3341	0.0650	1.1103	0.0814	1.05	406676	8.730	0.00
30.00	1.3991	0.0650	1.1926	0.0823	1.13	438300	8.839	0.00
31.00	1.4641	0.0650	1.2759	0.0832	1.21	470298	8.938	0.00
32.00	1.5291	0.0650	1.3599	0.0841	1.30	502638	9.028	0.00
33.00	1.5941	0.0650	1.4447	0.0848	1.38	535289	9.111	0.00
34.00	1.6590	0.0650	1.5302	0.0855	1.47	568227	9.187	0.00
35.00	1.7240	0.0650	1.6164	0.0861	1.55	601426	9.257	0.00
36.00	1.7890	0.0650	1.7031	0.0867	1.64	634868	9.322	0.00
37.00	1.8540	0.0650	1.7913	0.0882	1.72	668663	9.453	0.00
38.00	1.9197	0.0657	1.8799	0.0887	1.81	702833	9.530	0.00
39.00	1.9853	0.0657	1.9691	0.0892	1.90	737241	9.586	0.00
40.00	2.0510	0.0657	2.0587	0.0896	1.99	771836	9.634	0.00
41.00	2.1166	0.0657	2.1487	0.0900	2.08	806599	9.679	0.00
42.00	2.1823	0.0657	2.2391	0.0904	2.17	841519	9.721	0.00
43.00	2.2479	0.0657	2.3298	0.0907	2.26	876585	9.760	0.00
44.00	2.3136	0.0657	2.4209	0.0911	2.35	911786	9.797	0.00
45.00	2.3792	0.0657	2.5123	0.0914	2.44	947116	9.831	0.00
46.00	2.4449	0.0657	2.6040	0.0917	2.53	982565	9.863	0.00
47.00	2.5105	0.0657	2.6959	0.0920	2.63	1018126	9.893	0.00
48.00	2.5762	0.0657	2.7883	0.0924	2.72	1053798	9.925	0.00
49.00	2.6418	0.0657	2.8909	0.1026	2.81	1091055	10.774	0.00
50.00	2.7148	0.0729	2.9964	0.1055	2.92	1130651	11.224	0.00
51.00	2.7893	0.0745	3.1209	0.1245	3.03	1174035	12.879	0.00
52.00	2.8772	0.0879	3.2576	0.1367	3.15	1222938	14.290	0.00
53.00	2.9732	0.0960	3.4356	0.1780	3.30	1281052	17.996	0.00
54.00	3.0981	0.1249	3.6556	0.2201	3.49	1353761	22.398	0.00
55.00	3.2520	0.1539	3.9196	0.2639	3.72	1442810	27.074	0.00
56.00	3.4359	0.1839	4.2279	0.3083	4.00	1548830	31.826	0.00
57.00	3.6497	0.2138	4.5899	0.3620	4.32	1673304	37.326	0.00
58.00	3.8994	0.2497	5.0387	0.4488	4.70	1823368	46.043	0.00
59.00	4.2080	0.3086	5.6484	0.6097	5.21	2018103	62.144	0.00
60.00	4.6233	0.4154	9.7848	4.1364	7.37	2856583	403.678	0.00
61.00	7.4716	2.8482	11.0580	1.2731	10.22	3964011	211.560	0.00

62.00	8.2867	0.8151	11.6161	0.5582	11.65	4517010	95.662	0.00
63.00	8.6612	0.3745	11.9676	0.3515	12.30	4768777	44.209	0.00
64.00	8.8960	0.2348	12.2945	0.3269	12.68	4914028	36.486	0.00
65.00	9.1168	0.2208	12.4930	0.1985	12.96	5024325	24.790	0.00
66.00	9.2488	0.1320	12.6909	0.1979	13.18	5108192	21.803	0.00
67.00	9.3817	0.1329	12.8889	0.1980	13.38	5185790	21.307	0.00
68.00	9.5146	0.1329	13.0862	0.1974	13.57	5262487	21.303	0.00
69.00	9.6473	0.1327	13.2177	0.1315	13.75	5329494	15.924	0.00
70.00	9.7352	0.0879	13.3488	0.1311	13.89	5384033	14.375	0.00

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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
71.00	9.8231	0.0879	13.4806	0.1318	14.02	5435416	14.171	0.00
72.00	9.9116	0.0884	13.6110	0.1304	14.15	5486413	14.161	0.00

*** Basin: AREA3B Tmax(hrs): 60.67 Qmax(cfs): 183.660 Vmax(in): 10.76

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0003	0.0003	0.00	5	0.003	0.00
2.00	0.0448	0.0448	0.0127	0.0124	0.00	666	0.365	0.00
3.00	0.0895	0.0448	0.0367	0.0240	0.01	3534	1.229	0.00
4.00	0.1343	0.0448	0.0677	0.0309	0.02	9492	2.081	0.00
5.00	0.1790	0.0448	0.1030	0.0353	0.05	18258	2.789	0.00
6.00	0.2238	0.0448	0.1413	0.0383	0.08	29328	3.361	0.00
7.00	0.2685	0.0448	0.1817	0.0404	0.11	42230	3.807	0.00
8.00	0.3133	0.0448	0.2237	0.0420	0.15	56532	4.139	0.00
9.00	0.3580	0.0448	0.2669	0.0432	0.19	71857	4.375	0.00
10.00	0.4028	0.0448	0.3109	0.0441	0.23	87912	4.544	0.00
11.00	0.4475	0.0448	0.3557	0.0448	0.27	104495	4.669	0.00
12.00	0.4923	0.0448	0.4011	0.0454	0.31	121476	4.765	0.00
13.00	0.5371	0.0448	0.4469	0.0458	0.36	138765	4.840	0.00
14.00	0.5818	0.0448	0.4932	0.0462	0.40	156297	4.900	0.00
15.00	0.6266	0.0448	0.5397	0.0466	0.45	174026	4.949	0.00
16.00	0.6713	0.0448	0.5866	0.0468	0.50	191915	4.989	0.00
17.00	0.7161	0.0448	0.6337	0.0471	0.54	209938	5.023	0.00
18.00	0.7608	0.0448	0.6809	0.0473	0.59	228073	5.052	0.00
19.00	0.8056	0.0448	0.7284	0.0475	0.64	246303	5.076	0.00
20.00	0.8503	0.0448	0.7760	0.0476	0.68	264613	5.097	0.00
21.00	0.8951	0.0448	0.8237	0.0477	0.73	282994	5.115	0.00
22.00	0.9398	0.0448	0.8716	0.0479	0.78	301436	5.131	0.00
23.00	0.9846	0.0448	0.9195	0.0480	0.83	319930	5.144	0.00
24.00	1.0294	0.0448	0.9676	0.0481	0.87	338473	5.157	0.00
25.00	1.0742	0.0448	1.0376	0.0699	0.92	358386	5.906	0.00
26.00	1.1391	0.0650	1.1076	0.0701	0.98	380990	6.651	0.00
27.00	1.2041	0.0650	1.1778	0.0702	1.05	405640	7.044	0.00
28.00	1.2691	0.0650	1.2482	0.0703	1.11	431415	7.276	0.00
29.00	1.3341	0.0650	1.3186	0.0704	1.18	457901	7.439	0.00
30.00	1.3991	0.0650	1.3891	0.0705	1.25	484850	7.533	0.00
31.00	1.4641	0.0650	1.4596	0.0706	1.32	512052	7.579	0.00
32.00	1.5291	0.0650	1.5303	0.0706	1.39	539363	7.593	0.00

33.00	1.5941	0.0650	1.6010	0.0707	1.46	566711	7.601	0.00
34.00	1.6590	0.0650	1.6718	0.0708	1.53	594087	7.608	0.00
35.00	1.7240	0.0650	1.7426	0.0708	1.60	621487	7.614	0.00
36.00	1.7890	0.0650	1.8134	0.0709	1.67	648908	7.620	0.00
37.00	1.8540	0.0650	1.8850	0.0716	1.74	676393	7.649	0.00
38.00	1.9197	0.0657	1.9567	0.0717	1.82	703983	7.679	0.00
39.00	1.9853	0.0657	2.0284	0.0717	1.89	731656	7.695	0.00
40.00	2.0510	0.0657	2.1001	0.0717	1.96	759380	7.707	0.00
41.00	2.1166	0.0657	2.1718	0.0717	2.03	787138	7.715	0.00
42.00	2.1823	0.0657	2.2436	0.0718	2.10	814923	7.721	0.00

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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
43.00	2.2479	0.0657	2.3154	0.0718	2.17	842726	7.725	0.00
44.00	2.3136	0.0657	2.3872	0.0718	2.25	870542	7.728	0.00
45.00	2.3792	0.0657	2.4591	0.0718	2.32	898367	7.730	0.00
46.00	2.4449	0.0657	2.5309	0.0719	2.39	926201	7.733	0.00
47.00	2.5105	0.0657	2.6028	0.0719	2.46	954043	7.735	0.00
48.00	2.5762	0.0657	2.6747	0.0719	2.53	981892	7.737	0.00
49.00	2.6418	0.0657	2.7546	0.0799	2.61	1010232	8.008	0.00
50.00	2.7148	0.0729	2.8362	0.0816	2.68	1039651	8.336	0.00
51.00	2.7893	0.0745	2.9326	0.0964	2.76	1070917	9.034	0.00
52.00	2.8772	0.0879	3.0378	0.1052	2.85	1105070	9.939	0.00
53.00	2.9732	0.0960	3.1747	0.1370	2.95	1143916	11.642	0.00
54.00	3.0981	0.1249	3.3435	0.1688	3.07	1190310	14.133	0.00
55.00	3.2520	0.1539	3.5452	0.2017	3.22	1246494	17.081	0.00
56.00	3.4359	0.1839	3.7798	0.2346	3.39	1313780	20.300	0.00
57.00	3.6497	0.2138	4.0539	0.2741	3.59	1393372	23.918	0.00
58.00	3.8994	0.2497	4.3927	0.3388	3.84	1487694	28.484	0.00
59.00	4.2080	0.3086	4.8489	0.4562	4.13	1602595	35.350	0.00
60.00	4.6233	0.4154	7.9791	3.1302	4.75	1841013	97.104	0.00
61.00	7.4716	2.8482	8.8750	0.8960	5.99	2321312	169.728	0.00
62.00	8.2867	0.8151	9.2867	0.4117	7.30	2828221	111.888	0.00
63.00	8.6612	0.3745	9.5450	0.2582	8.17	3166513	76.052	0.00
64.00	8.8960	0.2348	9.7876	0.2427	8.79	3408827	58.566	0.00
65.00	9.1168	0.2208	9.9328	0.1452	9.26	3590444	42.332	0.00
66.00	9.2488	0.1320	10.0790	0.1461	9.59	3718702	28.922	0.00
67.00	9.3817	0.1329	10.2251	0.1461	9.82	3808056	20.719	0.00
68.00	9.5146	0.1329	10.3710	0.1459	10.00	3876554	17.336	0.00
69.00	9.6473	0.1327	10.4677	0.0967	10.15	3934117	14.644	0.00
70.00	9.7352	0.0879	10.5644	0.0967	10.27	3983098	12.568	0.00
71.00	9.8231	0.0879	10.6616	0.0972	10.39	4026542	11.568	0.00
72.00	9.9116	0.0884	10.7587	0.0971	10.49	4067287	11.068	0.00

*** Basin: AREA3C Tmax(hrs): 60.67 Qmax(cfs): 52.551 Vmax(in): 14.75

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0030	0.0030	0.00	13	0.007	0.00
2.00	0.0448	0.0448	0.0293	0.0263	0.00	376	0.195	0.00
3.00	0.0895	0.0448	0.0707	0.0414	0.02	1612	0.492	0.00

4.00	0.1343	0.0448	0.1201	0.0494	0.05	3844	0.748	0.00
5.00	0.1790	0.0448	0.1742	0.0542	0.08	6896	0.947	0.00
6.00	0.2238	0.0448	0.2315	0.0572	0.13	10580	1.100	0.00
7.00	0.2685	0.0448	0.2908	0.0593	0.18	14742	1.212	0.00
8.00	0.3133	0.0448	0.3516	0.0608	0.24	19247	1.291	0.00
9.00	0.3580	0.0448	0.4136	0.0619	0.29	23985	1.342	0.00
10.00	0.4028	0.0448	0.4763	0.0628	0.36	28880	1.377	0.00
11.00	0.4475	0.0448	0.5397	0.0634	0.42	33882	1.402	0.00
12.00	0.4923	0.0448	0.6037	0.0639	0.48	38963	1.421	0.00
13.00	0.5371	0.0448	0.6680	0.0643	0.54	44103	1.435	0.00
14.00	0.5818	0.0448	0.7327	0.0647	0.61	49289	1.446	0.00

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
15.00	0.6266	0.0448	0.7977	0.0650	0.67	54512	1.455	0.00
16.00	0.6713	0.0448	0.8629	0.0652	0.73	59764	1.463	0.00
17.00	0.7161	0.0448	0.9283	0.0654	0.80	65040	1.469	0.00
18.00	0.7608	0.0448	0.9938	0.0656	0.87	70337	1.474	0.00
19.00	0.8056	0.0448	1.0596	0.0657	0.93	75650	1.478	0.00
20.00	0.8503	0.0448	1.1254	0.0658	1.00	80978	1.482	0.00
21.00	0.8951	0.0448	1.1913	0.0660	1.06	86318	1.485	0.00
22.00	0.9398	0.0448	1.2574	0.0660	1.13	91668	1.488	0.00
23.00	0.9846	0.0448	1.3235	0.0661	1.19	97028	1.490	0.00
24.00	1.0294	0.0448	1.3898	0.0663	1.26	102396	1.492	0.00
25.00	1.0742	0.0448	1.4861	0.0963	1.33	108155	1.707	0.00
26.00	1.1391	0.0650	1.5824	0.0964	1.41	114686	1.921	0.00
27.00	1.2041	0.0650	1.6789	0.0965	1.50	121801	2.032	0.00
28.00	1.2691	0.0650	1.7755	0.0966	1.59	129236	2.098	0.00
29.00	1.3341	0.0650	1.8721	0.0967	1.68	136871	2.143	0.00
30.00	1.3991	0.0650	1.9689	0.0967	1.78	144634	2.169	0.00
31.00	1.4641	0.0650	2.0656	0.0968	1.88	152466	2.182	0.00
32.00	1.5291	0.0650	2.1625	0.0968	1.97	160325	2.184	0.00
33.00	1.5941	0.0650	2.2594	0.0969	2.07	168191	2.186	0.00
34.00	1.6590	0.0650	2.3563	0.0969	2.17	176062	2.187	0.00
35.00	1.7240	0.0650	2.4533	0.0970	2.26	183936	2.188	0.00
36.00	1.7890	0.0650	2.5502	0.0970	2.36	191815	2.189	0.00
37.00	1.8540	0.0650	2.6483	0.0980	2.46	199709	2.197	0.00
38.00	1.9197	0.0657	2.7463	0.0981	2.55	207631	2.205	0.00
39.00	1.9853	0.0657	2.8444	0.0981	2.65	215575	2.209	0.00
40.00	2.0510	0.0657	2.9425	0.0981	2.75	223532	2.212	0.00
41.00	2.1166	0.0657	3.0406	0.0981	2.85	231497	2.214	0.00
42.00	2.1823	0.0657	3.1388	0.0981	2.95	239468	2.215	0.00
43.00	2.2479	0.0657	3.2369	0.0982	3.04	247443	2.216	0.00
44.00	2.3136	0.0657	3.3351	0.0982	3.14	255421	2.216	0.00
45.00	2.3792	0.0657	3.4333	0.0982	3.24	263400	2.217	0.00
46.00	2.4449	0.0657	3.5315	0.0982	3.34	271380	2.217	0.00
47.00	2.5105	0.0657	3.6297	0.0982	3.44	279362	2.217	0.00
48.00	2.5762	0.0657	3.7280	0.0982	3.53	287345	2.218	0.00
49.00	2.6418	0.0657	3.8371	0.1091	3.63	295467	2.295	0.00
50.00	2.7148	0.0729	3.9486	0.1115	3.74	303898	2.389	0.00

51.00	2.7893	0.0745	4.0803	0.1316	3.85	312858	2.589	0.00
52.00	2.8772	0.0879	4.2239	0.1437	3.97	322644	2.848	0.00
53.00	2.9732	0.0960	4.4110	0.1871	4.10	333773	3.335	0.00
54.00	3.0981	0.1249	4.6415	0.2305	4.27	347063	4.048	0.00
55.00	3.2520	0.1539	4.9168	0.2754	4.47	363156	4.892	0.00
56.00	3.4359	0.1839	5.2371	0.3203	4.70	382425	5.813	0.00
57.00	3.6497	0.2138	5.6113	0.3742	4.98	405217	6.849	0.00
58.00	3.8994	0.2497	6.0737	0.4624	5.32	432223	8.155	0.00
59.00	4.2080	0.3086	6.6962	0.6226	5.72	465117	10.119	0.00
60.00	4.6233	0.4154	10.9665	4.2703	6.56	533352	27.789	0.00
61.00	7.4716	2.8482	12.1885	1.2221	8.25	670787	48.564	0.00
62.00	8.2867	0.8151	12.7501	0.5616	10.03	815824	32.013	0.00

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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
63.00	8.6612	0.3745	13.1023	0.3522	11.22	912613	21.759	0.00
64.00	8.8960	0.2348	13.4332	0.3310	12.08	981940	16.756	0.00
65.00	9.1168	0.2208	13.6313	0.1981	12.72	1033899	12.111	0.00
66.00	9.2488	0.1320	13.8306	0.1993	13.17	1070592	8.274	0.00
67.00	9.3817	0.1329	14.0299	0.1993	13.48	1096153	5.927	0.00
68.00	9.5146	0.1329	14.2289	0.1990	13.72	1115748	4.959	0.00
69.00	9.6473	0.1327	14.3608	0.1319	13.92	1132214	4.189	0.00
70.00	9.7352	0.0879	14.4927	0.1319	14.10	1146226	3.595	0.00
71.00	9.8231	0.0879	14.6253	0.1326	14.25	1158653	3.309	0.00
72.00	9.9116	0.0884	14.7577	0.1324	14.39	1170308	3.166	0.00

10 yr
24 hr

*** Basin: AREA1D Tmax(hrs): 12.30 Qmax(cfs): 304.817 Vmax(in): 6.68

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
2.00	0.0960	0.0960	0.0000	0.0000	0.00	0	0.000	0.00
3.00	0.2000	0.1040	0.0032	0.0032	0.00	432	0.240	0.00
4.00	0.3111	0.1111	0.0241	0.0209	0.01	4186	1.845	0.00
5.00	0.4320	0.1209	0.0662	0.0421	0.04	14919	4.118	0.00
6.00	0.5680	0.1360	0.1272	0.0611	0.08	33837	6.393	0.00
7.00	0.7120	0.1440	0.2145	0.0872	0.15	61954	9.228	0.00
8.00	0.8799	0.1679	0.3305	0.1161	0.24	100992	12.460	0.00
9.00	1.0720	0.1922	0.4930	0.1625	0.37	154692	17.374	0.00
10.00	1.3120	0.2400	0.7141	0.2211	0.54	228750	23.770	0.00
11.00	1.6080	0.2960	1.0817	0.3676	0.80	340192	38.142	0.00
12.00	2.0640	0.4561	3.5901	2.5084	1.89	802270	218.568	0.00
13.00	4.8560	2.7920	4.7887	1.1986	3.57	1513616	176.624	0.00
14.00	6.0560	1.2000	5.1777	0.3890	4.69	1988884	87.414	0.00
15.00	6.4560	0.4001	5.4506	0.2728	5.24	2219175	40.525	0.00
16.00	6.7360	0.2800	5.6690	0.2185	5.53	2342807	28.160	0.00
17.00	6.9600	0.2240	5.8487	0.1797	5.75	2434413	22.732	0.00
18.00	7.1440	0.1840	6.0052	0.1565	5.93	2510093	19.312	0.00
19.00	7.3040	0.1600	6.1461	0.1409	6.08	2575549	17.052	0.00
20.00	7.4480	0.1440	6.2788	0.1328	6.22	2634743	15.834	0.00
21.00	7.5840	0.1360	6.3888	0.1099	6.35	2687911	13.704	0.00

N

Volume (cf) Rate (cfs)

22.00	7.6960	0.1120	6.4985	0.1098	6.46	2736109	13.073	0.00
23.00	7.8080	0.1120	6.6006	0.1020	6.57	2781631	12.217	0.00
24.00	7.9121	0.1041	6.6840	0.0834	6.66	2822703	10.601	0.00
25.00	8.0000	0.0879	6.6840	0.0000	6.72	2847235	3.028	0.00
26.00	8.0000	0.0000	6.6840	0.0000	6.74	2853841	0.642	0.00
27.00	8.0000	0.0000	6.6840	0.0000	6.74	2855016	0.011	0.00
28.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
29.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
30.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
31.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
32.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
33.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
34.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00

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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
35.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
36.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
37.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
38.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
39.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
40.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
41.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
42.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
43.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
44.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
45.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
46.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
47.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
48.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
49.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
50.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
51.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
52.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
53.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
54.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
55.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
56.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
57.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
58.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
59.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
60.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
61.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
62.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
63.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
64.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
65.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
66.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
67.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
68.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00

69.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
70.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
71.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00
72.00	8.0000	0.0000	6.6840	0.0000	6.74	2855035	0.000	0.00

*** Basin: AREA2D Tmax(hrs): 12.26 Qmax(cfs): 299.779 Vmax(in): 6.68

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
2.00	0.0960	0.0960	0.0000	0.0000	0.00	0	0.000	0.00
3.00	0.2000	0.1040	0.0032	0.0032	0.00	474	0.264	0.00
4.00	0.3111	0.1111	0.0241	0.0209	0.01	4255	1.837	0.00
5.00	0.4320	0.1209	0.0662	0.0421	0.04	14737	3.987	0.00
6.00	0.5680	0.1360	0.1272	0.0610	0.08	32827	6.063	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [17]

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
7.00	0.7120	0.1440	0.2144	0.0872	0.15	59390	8.694	0.00
8.00	0.8799	0.1679	0.3305	0.1160	0.25	96084	11.692	0.00
9.00	1.0720	0.1922	0.4930	0.1625	0.38	146631	16.390	0.00
10.00	1.3120	0.2400	0.7139	0.2209	0.56	216495	22.423	0.00
11.00	1.6080	0.2960	1.0816	0.3677	0.83	322312	36.364	0.00
12.00	2.0640	0.4561	3.6094	2.5278	2.06	800070	229.057	0.00
13.00	4.8560	2.7920	4.7893	1.1799	3.85	1493182	156.005	0.00
14.00	6.0560	1.2000	5.1780	0.3888	4.90	1899409	69.677	0.00
15.00	6.4560	0.4001	5.4505	0.2725	5.38	2083969	32.857	0.00
16.00	6.7360	0.2800	5.6689	0.2184	5.64	2187974	24.924	0.00
17.00	6.9600	0.2240	5.8487	0.1798	5.85	2269431	20.330	0.00
18.00	7.1440	0.1840	6.0053	0.1566	6.03	2337146	17.290	0.00
19.00	7.3040	0.1600	6.1461	0.1409	6.18	2395839	15.318	0.00
20.00	7.4480	0.1440	6.2788	0.1327	6.32	2449214	14.335	0.00
21.00	7.5840	0.1360	6.3888	0.1099	6.44	2497314	12.387	0.00
22.00	7.6960	0.1120	6.4985	0.1098	6.55	2541004	11.886	0.00
23.00	7.8080	0.1120	6.6006	0.1021	6.66	2582332	11.074	0.00
24.00	7.9121	0.1041	6.6833	0.0827	6.76	2619371	9.503	0.00
25.00	8.0000	0.0879	6.6833	0.0000	6.81	2640440	2.202	0.00
26.00	8.0000	0.0000	6.6833	0.0000	6.82	2644915	0.284	0.00
27.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
28.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
29.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
30.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
31.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
32.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
33.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
34.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
35.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
36.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
37.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
38.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
39.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00

40.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
41.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
42.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
43.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
44.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
45.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
46.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
47.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
48.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
49.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
50.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
51.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
52.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
53.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
54.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [18]
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LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
55.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
56.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
57.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
58.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
59.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
60.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
61.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
62.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
63.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
64.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
65.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
66.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
67.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
68.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
69.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
70.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
71.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00
72.00	8.0000	0.0000	6.6833	0.0000	6.82	2645427	0.000	0.00

*** Basin: AREA3D Tmax(hrs): 12.67 Qmax(cfs): 37.845 Vmax(in): 7.76

0.00	0.0000	0.0000	0.0000	0.0000	0.00	0	0.000	0.00
1.00	0.0000	0.0000	0.0117	0.0117	0.00	69	0.038	0.00
2.00	0.0960	0.0960	0.0698	0.0580	0.01	1011	0.485	0.00
3.00	0.2000	0.1040	0.1540	0.0843	0.05	3788	1.058	0.00
4.00	0.3111	0.1111	0.2571	0.1030	0.10	8517	1.569	0.00
5.00	0.4320	0.1209	0.3801	0.1230	0.18	15037	2.053	0.00
6.00	0.5680	0.1360	0.5147	0.1346	0.29	23193	2.478	0.00
7.00	0.7120	0.1440	0.6749	0.1602	0.40	32930	2.932	0.00
8.00	0.8799	0.1679	0.8608	0.1859	0.55	44407	3.444	0.00
9.00	1.0720	0.1922	1.0953	0.2345	0.71	57970	4.091	0.00
10.00	1.3120	0.2400	1.3866	0.2913	0.91	74371	5.021	0.00

11.00	1.6080	0.2960	1.8379	0.4512	1.18	95571	6.757	0.00
12.00	2.0640	0.4561	4.6183	2.7805	1.71	139348	17.564	0.00
13.00	4.8560	2.7920	5.8177	1.1994	2.90	236089	36.181	0.00
14.00	6.0560	1.2000	6.2174	0.3997	4.23	343671	23.587	0.00
15.00	6.4560	0.4001	6.4971	0.2797	5.11	415121	16.108	0.00
16.00	6.7360	0.2800	6.7209	0.2238	5.73	466286	12.317	0.00
17.00	6.9600	0.2240	6.9048	0.1839	6.21	504919	9.146	0.00
18.00	7.1440	0.1840	7.0647	0.1599	6.56	533025	6.469	0.00
19.00	7.3040	0.1600	7.2086	0.1439	6.80	553019	4.639	0.00
20.00	7.4480	0.1440	7.3445	0.1359	6.98	567946	3.653	0.00
21.00	7.5840	0.1360	7.4564	0.1119	7.14	580192	3.151	0.00
22.00	7.6960	0.1120	7.5683	0.1119	7.27	590981	2.843	0.00
23.00	7.8080	0.1120	7.6723	0.1040	7.39	600878	2.655	0.00
24.00	7.9121	0.1041	7.7602	0.0878	7.50	609959	2.391	0.00
25.00	8.0000	0.0879	7.7602	0.0000	7.59	617049	1.548	0.00
26.00	8.0000	0.0000	7.7602	0.0000	7.64	621348	0.841	0.00

Advanced Interconnected Channel & Pond Routing (ICPR Ver 2.20) [19]

LAMB DIARY FARM RUNOFF ESTIMATION

********** Basin Time Series - P10 **********

Time (hrs)	Sum Rain(in)	Inc Rain(in)	Sum Excess Rain(in)	Inc Excess Rain(in)	Volume (in)	Volume (cf)	Rate (cfs)	Velocity (fps)
27.00	8.0000	0.0000	7.7602	0.0000	7.67	623706	0.469	0.00
28.00	8.0000	0.0000	7.7602	0.0000	7.69	625005	0.253	0.00
29.00	8.0000	0.0000	7.7602	0.0000	7.69	625659	0.110	0.00
30.00	8.0000	0.0000	7.7602	0.0000	7.70	625919	0.034	0.00
31.00	8.0000	0.0000	7.7602	0.0000	7.70	625988	0.004	0.00
32.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
33.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
34.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
35.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
36.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
37.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
38.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
39.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
40.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
41.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
42.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
43.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
44.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
45.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
46.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
47.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
48.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
49.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
50.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
51.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
52.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
53.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
54.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
55.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
56.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
57.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00

58.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
59.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
60.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
61.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
62.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
63.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
64.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
65.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
66.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
67.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
68.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
69.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
70.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
71.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00
72.00	8.0000	0.0000	7.7602	0.0000	7.70	625994	0.000	0.00

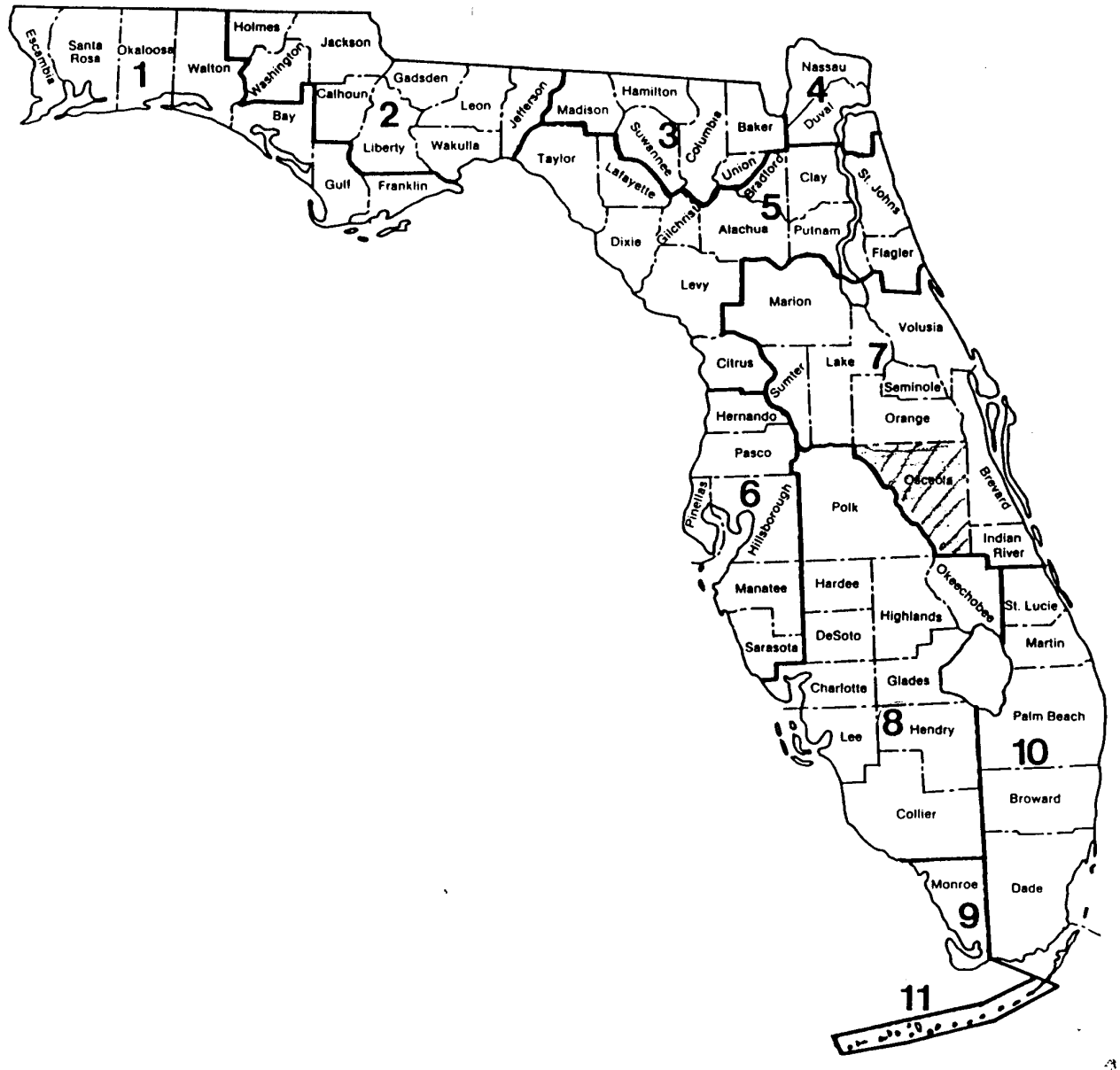
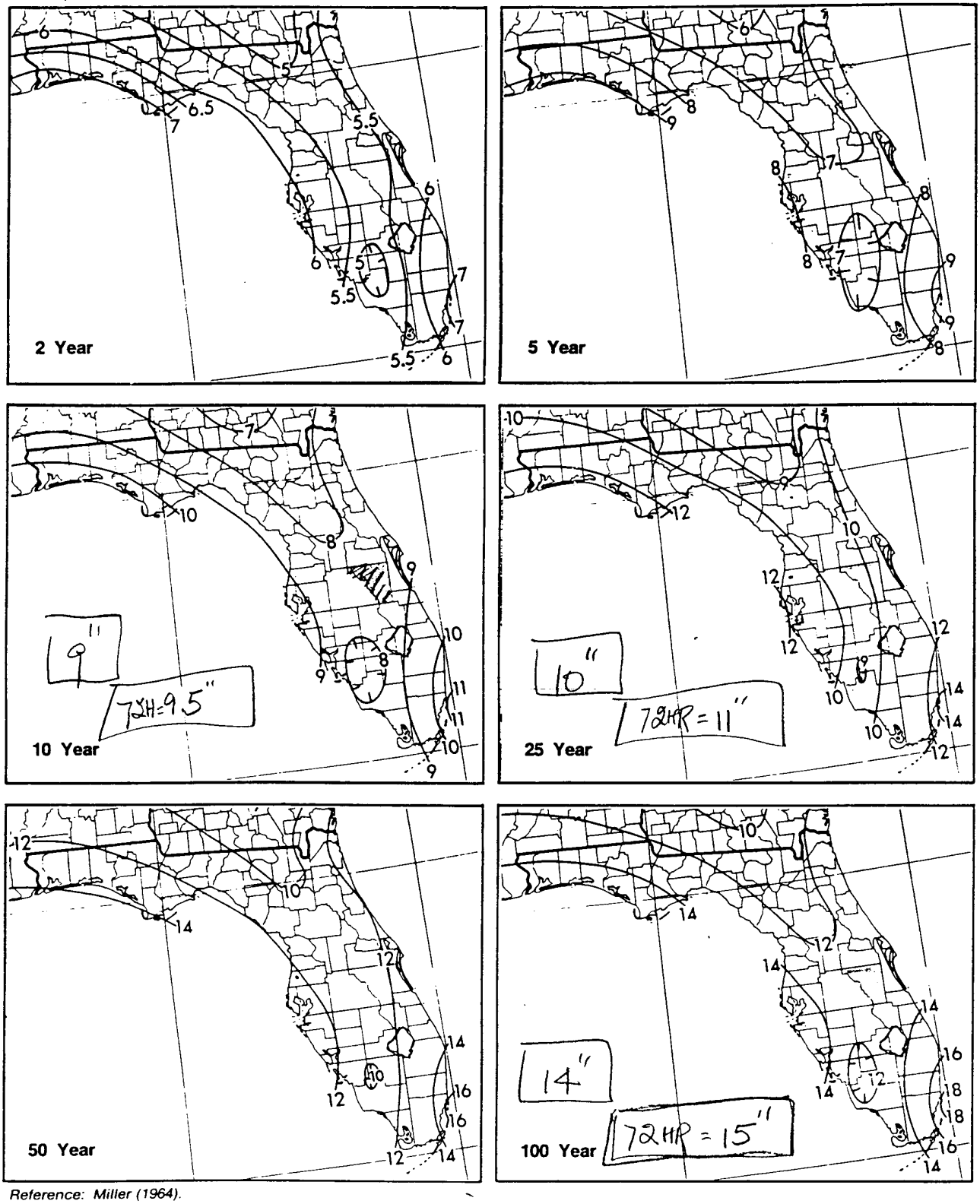


FIGURE 5-1
Zones for Precipitation Intensity-Duration-Frequency (IDF) Curves Developed by the Department

ATTACHMENT 5

2 DAY

All Depth Contours in Inches



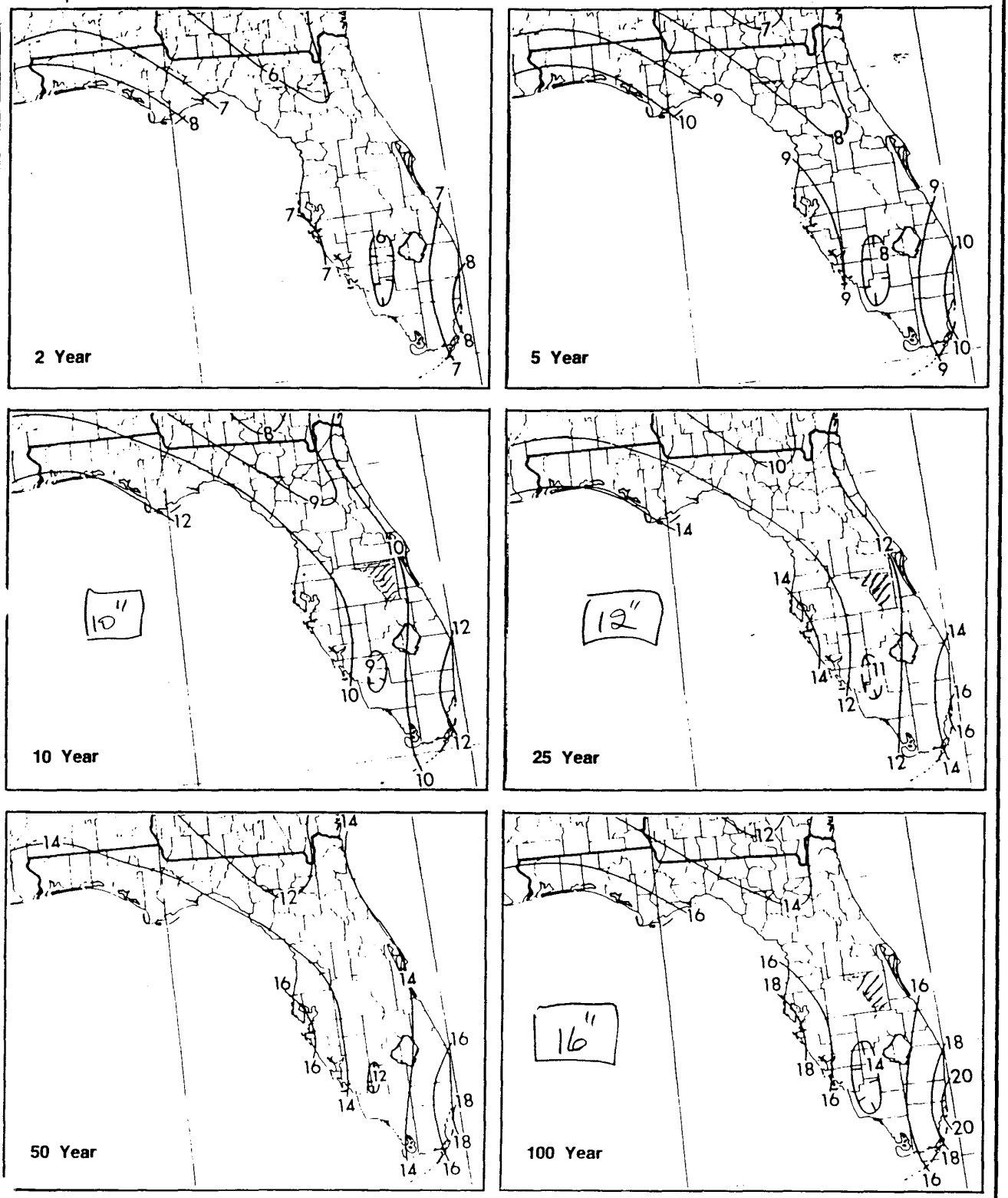
Reference: Miller (1964).

FIGURE 5-14

2-Day Precipitation Depth Data for 2-, 5-, 10-, 25-, 50-, and 100-Year Frequencies

4 DAY

All Depth Contours in Inches



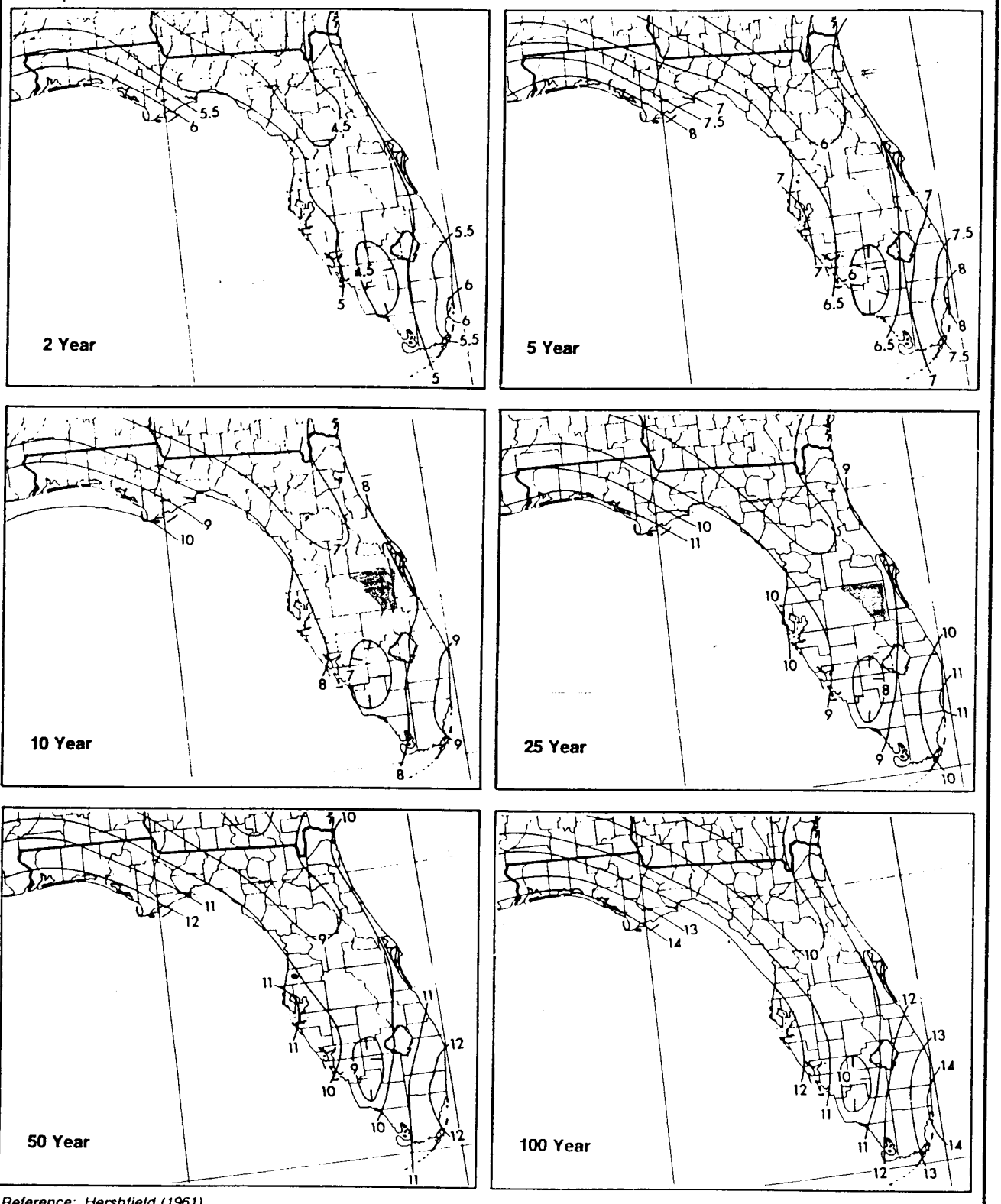
Reference: Miller (1964)

FIGURE 5-15

4-Day Precipitation Depth Data for 2-, 5-, 10-, 25-, 50-, and 100-Year Frequencies

1 DAY

All Depth Contours in Inches



Reference: Hershfield (1961).

FIGURE 5-13

1-Day Precipitation Depth Data for 2-, 5-, 10-, 25-, 50-, and 100-Year Frequencies

APPENDIX B

WETLAND SYSTEM DESIGN MEMO

Wetland Solutions, Inc.

2809 NW 161 Court
Gainesville, FL 32609
(386) 462-1003
(386) 462-3196 fax

Memorandum

To: Terry Horan/HSA
From: Robert L. Knight/WSI
Date: October 16, 2002

Subject: Estimated Performance of the Proposed Lamb Island Dairy Remediation Project

Executive Summary

This memorandum provides a preliminary evaluation of the efficacy of a system of treatment ponds and wetlands at the former Lamb Island Dairy in Okeechobee County, Florida. HSA Engineers and Scientists are in the process of developing a conceptual design for water quality remediation at the site to control off-site releases of total phosphorus (TP) and other pollutants.

This memorandum provides an estimate of the likely performance of two ponds and four Eco-Reactor (constructed wetland) cells operating in series. Based on the assumptions used for this analysis, it is estimated that the annual average outflow TP from the proposed treatment train will be about 0.18 mg/L. The estimated hydraulic residence time in the system is about 120 days.

There are numerous considerations for engineering design and operations and management that could affect actual performance of the proposed project. All of the conceptual design and modeling performance assumptions used in this analysis should be verified and updated with site-specific information prior to and during final project design.

Introduction

This memorandum describes estimates of removal of TP from a proposed dairy remediation project in south Florida. The Lamb Island Dairy property includes 808 acres in Okeechobee County, Florida, north of Lake Okeechobee. Water flows from this property into Cypress Slough and Chandler Slough. The property was owned and

operated as a dairy from about 1981 until 1994, when it was purchased by the South Florida Water Management District (District). Beef cattle were kept on the property until about 1998.

HSA Engineers and Scientists (HSA) has been retained to implement a TP remediation program on the former dairy site. HSA retained Wetland Solutions, Inc. (WSI) to provide estimates of water quality removals in natural treatment processes included in the remediation plan, including ponds and constructed wetland cells called "Eco-Reactors". This memorandum describes the methods and results of WSI's performance evaluation.

This performance evaluation is based on existing information when available, and on assumptions when information is not yet complete. As additional site-specific information becomes available during final design, the assumptions and conclusions detailed in this memorandum should be updated.

The proposed remediation system consists of two ponds and four Eco-Reactor cells:

- Pond 2 (2.21 ac)
- Pond 3 (5.16 ac)
- Eco-Reactor Tank 1 (1.38 ac)
- Eco-Reactor Tank 2 (1.12 ac)
- Eco-Reactor Tank 3 (0.98 ac)
- Eco-Reactor Tank 4 (3.01 ac)

for an estimated combined treatment area of about 13.9 ac.

For the purposes of this evaluation it is assumed that the ponds will be relatively free of vegetation due to their depth (6 and 16 feet for Ponds 2 and 3, respectively) and that the Eco-Reactor cells will be maintained with relatively shallow water depths (12 to 18 inches) so they will be covered with a full stand of emergent vegetation such as cattails.

Methods

Historical records have been used as the basis to anticipate future flows and constituent mass loads to the remediation project. An annual average inflow of 1,090 m^3/d (200 gpm) was provided to WSI by HSA. The annual average inflow TP was taken from long-term water quality data gathered by the District and is assumed to be 3.33 mg/L. A mass balance spreadsheet was been developed to illustrate the estimated flows and loads to each of the project components.

Annual average water balances for each of the 6 project components were estimated based on long-term average rainfall from SWET (2002) of 51 in/yr and estimated evapotranspiration (ET) of 54 in/yr based on pan evaporation data from Station ID 858950 (NCDD, 1995) and a pan factor of 0.70 from Kadlec and Knight (1996) for treatment wetlands.

Pond removal performance was estimated using the average TP mass removal efficiency for wet detention ponds published by Harper (1995). This method assumes 65% mass reduction on an annual average basis. The k-C* model of Kadlec and Knight (1996) was

used for estimating performance of the Eco-Reactor cells. Model parameters for surface-flow, marsh wetlands were used in this model.

Results

Exhibit 1 summarizes the performance assessment for the proposed Lamb Island Dairy project. Appendix Tables A-1 through A-6 provide detailed flow and mass balance estimates for each cell in the treatment train. Based on the methods and assumptions described above, the two ponds are expected to reduce the annual average concentration of TP from 3.33 to 0.41 mg/L with a nominal hydraulic residence time of about 109 days. The Eco-Reactor is expected to further reduce this annual average TP concentration to about 0.18 mg/L, following an additional nominal detention time of 11 days. Flow is expected to decrease slightly based on long-term average climatic conditions from about 1,090 to1,077 m^3/d (200 to 198 gpm).

The methods employed in this analysis do not provide estimates of associated uncertainty in these estimates. However, the analysis was rerun with the more optimistic and pessimistic pond removal rates proposed by Harper (1995) and updated TP k-C* model parameters summarized by Knight (1999). Based on these observed performance values, it appears that a reasonable range of average estimates around the final pond performance estimate of 0.41 mg/L is 1.3 to 0.10 mg/L and a reasonable range around the wetland performance estimate of 0.18 mg/L is 0.26 to 0.04 mg/L.

Other Considerations

Actual flows and loads to the proposed remediation system are likely to be variable due to periodic rainfall and seasonally-varying ET rates. These flow and mass load variations are likely to result in variable system performance. In addition, higher flows may result in hydraulic head loss differences and time-varying water depths in the ponds and wetland cells. Excessive water depths in the wetland cells may affect plant community structure and ultimately, treatment performance. For this reason a hydraulic profile for system water control structures and cell configurations over the range of possible flow rates must be evaluated during system design.

Pond/open water areas are not as effective as densely-vegetated emergent wetlands for TP removal (Kadlec and Knight, 1996). For these reasons it is important to insure that water depths will not exceed the growth requirements for the rooted macrophytes in the Eco-Reactor cells, resulting in significant areas of open water.

References

Harper, H.H. 1995. Pollutant Removal Efficiencies for typical Stormwater Management Systems in Florida. pp. 6-19 in: Proceedings of the 4th Biennial Stormwater Research Conference, October 18-20, 1995, Clearwater Beach, FL. Published by the Southwest Florida Water Management District, Brooksville, FL.

Kadlec, R.H. and R.L. Knight. 1996. *Treatment Wetlands*. CRC/Lewis Publishers, Boca Raton, FL. 893 pp.

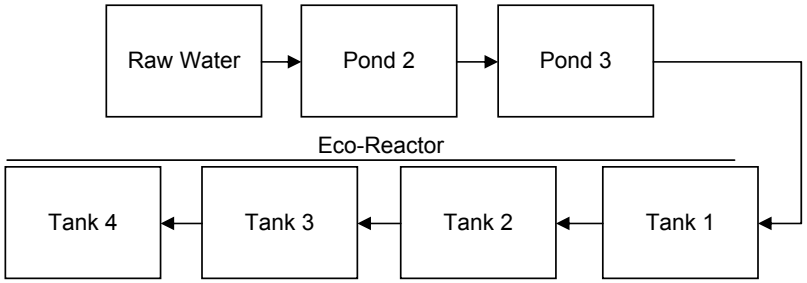
Knight, R.L. 1999. Okeechobee Stormwater Treatment Areas – Taylor Creek and Nubbin Slough. Memorandum dated March 26, 1999 prepared for Stanley Consultants. Appendix C in: Stanley Consultants, 1999. Prefinal Report Okeechobee water Retention Areas project.Contract DAW17-98-D-0014. 41 pp.

National Climatic Data Center (NCDD) 1995. Alabama Florida Georgia Cooperative Summary of the Day. Volume 20, June 1995. Ashville, N.C.

Soil and Water Engineering Technology, Inc. (SWET). 2002. Agriculture Nutrient Management Assessment for Lamb Island Dairy Buyout Farm. Prepared for the Florida Department of Agriculture and Consumer Services. 24 pp.

EXHIBIT 1

Lamb Island Dairy Conceptual Treatment Process Estimated Annual Average Performance



Raw Water Inflow (m^3/d) =	1,090	TP In (mg/L) =	3.33

Unit	Area (ac)	Depth (m)	Detention Time (d)	Cumulative Detention Time (d)	Q_{in} (m^3/d)	Q_{delta} (%)	TP_{in} (mg/L)	TP_{in} (lb/d)	TP_{in} (lb/ac/d)	TP_{rem} (%)
Pond 2	2.21	1.83	15	15	1,090	-0.19	3.33	8.00	3.62	65
Pond 3	5.16	4.88	94	109	1,088	-0.45	1.17	2.80	0.54	65
Eco-Reactor										
Tank 1	1.38	0.46	2	111	1,083	-0.12	0.41	0.98	0.71	16
Tank 2	1.12	0.46	2	113	1,082	-0.10	0.35	0.83	0.74	13
Tank 3	0.98	0.46	2	115	1,081	-0.09	0.30	0.72	0.73	11
Tank 4	3.01	0.46	5	120	1,080	-0.27	0.27	0.64	0.21	31
Discharge	---	---	---	---	1,077	---	0.18	0.44	0.15	---

Pond Model Est. Removals [a]	
65%	assumed TP load reduction for pond

Water Balance	
rain (in/yr) =	51.0
ET (in/yr) =	54.4
perc (in/yr) =	0

Eco-Reactor Constructed Wetland Removals [b]	
k-C* Model Parameters	
k_{20}	12
C*	0
θ	1.00
k	12

Design temperature (C^o): 25

Note(s):

Rainfall Period-of-Record: 1988-99 (SWET, 2002)

Pan Evaporation Period-of-Record: 1956-93 Stn ID: 858950 (NCDD, 1995)

ET = Pan Evaporation * 0.7

[a] Annual Average Florida wet detention pond load reduction (range 38-91%) from Harper, 1995.

[b] Constructed surface flow treatment wetlands from Kadlec and Knight, 1996

Appendix A

Detailed Flow and Mass Balance Tables

APPENDIX A-1

Lamb Island Dairy Conceptual Treatment Process Estimated Annual Average Performance for Pond # 2

Parameter	acres	ft^2	hectares	m^2
Area =	2.21	96,268	0.89	8,943

Parameter	mgd	gpm	in/d	in/yr	m^3/d	cm/d	m/yr
Q_{in} =	0.288	200	4.8	1,752	1,090	12.2	44.5
Q_{rain} =	0.008	5.8	0.140	51.0	31.7	0.355	1.295
Q_{ET} =	0.009	6.2	0.149	54.4	33.9	0.379	1.382
Q_{perc} =	0.000	0.0	0.000	0	0.0	0.000	0.000
Q_{out} =	0.287	200	4.8	1,748	1,088	12.2	44.4

Parameter	mg/L	lb/d	lb/ac/d	kg/d	kg/ha/d
TP_{in} =	3.33	8.00	3.62	3.63	4.06
TP_{out} =	1.17	2.80	1.27	1.27	1.42
TP_{rem} =	2.16	5.20	2.35	2.36	2.64
TP_{rem} (%) =	64.9	65.0	65.0	65.0	65.0

Notes:

65% assumed TP load reduction for pond

APPENDIX A-2

Lamb Island Dairy Conceptual Treatment Process Estimated Annual Average Performance for Pond # 3

Parameter	acres	ft^2	hectares	m^2
Area =	5.16	224,770	2.09	20,882

Parameter	mgd	gpm	in/d	in/yr	m^3/d	cm/d	m/yr
Q_{in} =	0.287	200	2.1	749	1,088	5.2	19.0
Q_{rain} =	0.020	13.6	0.140	51.0	74.1	0.355	1.295
Q_{ET} =	0.021	14.5	0.149	54.4	79.1	0.379	1.382
Q_{perc} =	0.000	0.0	0.000	0	0.0	0.000	0.000
Q_{out} =	0.286	199	2.0	745	1,083	5.2	18.9

Parameter	mg/L	lb/d	lb/ac/d	kg/d	kg/ha/d
TP_{in} =	1.17	2.80	0.54	1.27	0.61
TP_{out} =	0.41	0.98	0.19	0.44	0.21
TP_{rem} =	0.76	1.82	0.35	0.83	0.40
TP_{rem} (%) =	64.8	65.0	65.0	65.0	65.0

Notes:

65% assumed TP load reduction for pond

APPENDIX A-3

Lamb Island Dairy Conceptual Treatment Process Estimated Annual Average Performance for Eco-Reactor Tank #1

Parameter	acres	ft^2	hectares	m^2
Area =	1.38	60,113	0.56	5,585

Parameter	mgd	gpm	in/d	in/yr	m^3/d	cm/d	m/yr
Q_{in} =	0.286	199	7.6	2,787	1,083	19.4	70.8
Q_{rain} =	0.005	3.6	0.140	51.0	19.8	0.355	1.295
Q_{ET} =	0.006	3.9	0.149	54.4	21.1	0.379	1.382
Q_{perc} =	0.000	0.0	0.000	0	0.0	0.000	0.000
Q_{out} =	0.286	198	7.6	2,784	1,082	19.4	70.7

Parameter	mg/L	lb/d	lb/ac/d	kg/d	kg/ha/d	Model Parameters	
TP_{in} =	0.41	0.98	0.71	0.44	0.80	**k_{20}**	12
TP_{out} =	0.35	0.83	0.60	0.37	0.67	**C***	0
TP_{rem} =	0.06	0.15	0.11	0.07	0.12	**θ**	1.00
TP_{rem} (%) =	15.6	15.7	15.7	15.7	15.7	**k**	12

APPENDIX A-4

Lamb Island Dairy Conceptual Treatment Process Estimated Annual Average Performance for Eco-Reactor Tank #2

Parameter	acres	ft^2	hectares	m^2
Area =	1.12	48,787	0.45	4,532

Parameter	mgd	gpm	in/d	in/yr	m^3/d	cm/d	m/yr
Q_{in} =	0.286	198	9.4	3,430	1,082	23.9	87.1
Q_{rain} =	0.004	3.0	0.140	51.0	16.1	0.355	1.295
Q_{ET} =	0.005	3.1	0.149	54.4	17.2	0.379	1.382
Q_{perc} =	0.000	0.0	0.000	0	0.0	0.000	0.000
Q_{out} =	0.286	198	9.4	3,427	1,081	23.8	87.0

Parameter	mg/L	lb/d	lb/ac/d	kg/d	kg/ha/d	Model Parameters	
TP_{in} =	0.35	0.83	0.74	0.37	0.83	**k_{20}**	12
TP_{out} =	0.30	0.72	0.64	0.33	0.72	**C***	0
TP_{rem} =	0.04	0.11	0.10	0.05	0.11	**θ**	1.00
TP_{rem} (%) =	12.9	13.0	13.0	13.0	13.0	**k**	12

APPENDIX A-5

Lamb Island Dairy Conceptual Treatment Process Estimated Annual Average Performance for Eco-Reactor Tank #3

Parameter	acres	ft^2	hectares	m^2
Area =	0.98	42,689	0.40	3,966

Parameter	mgd	gpm	in/d	in/yr	m^3/d	cm/d	m/yr
Q_{in} =	0.286	198	10.7	3,916	1,081	27.3	99.5
Q_{rain} =	0.004	2.6	0.140	51.0	14.1	0.355	1.295
Q_{ET} =	0.004	2.8	0.149	54.4	15.0	0.379	1.382
Q_{perc} =	0.000	0.0	0.000	0	0.0	0.000	0.000
Q_{out} =	0.285	198	10.7	3,913	1,080	27.2	99.4

Parameter	mg/L	lb/d	lb/ac/d	kg/d	kg/ha/d	Model Parameters	
TP_{in} =	0.30	0.72	0.73	0.33	0.82	**k_{20}**	12
TP_{out} =	0.27	0.64	0.65	0.29	0.73	**C***	0
TP_{rem} =	0.03	0.08	0.08	0.04	0.09	**θ**	1.00
TP_{rem} (%) =	11.4	11.4	11.4	11.4	11.4	**k**	12

APPENDIX A-6

Lamb Island Dairy Conceptual Treatment Process Estimated Annual Average Performance for Eco-Reactor Tank #4

Parameter	acres	ft^2	hectares	m^2
Area =	3.01	131,116	1.22	12,181

Parameter	mgd	gpm	in/d	in/yr	m^3/d	cm/d	m/yr
Q_{in} =	0.285	198	3.5	1,274	1,080	8.9	32.4
Q_{rain} =	0.011	7.9	0.140	51.0	43.2	0.355	1.295
Q_{ET} =	0.012	8.5	0.149	54.4	46.1	0.379	1.382
Q_{perc} =	0.000	0.0	0.000	0	0.0	0.000	0.000
Q_{out} =	0.284	198	3.5	1,270	1,077	8.8	32.3

Parameter	mg/L	lb/d	lb/ac/d	kg/d	kg/ha/d	Model Parameters	
TP_{in} =	0.27	0.64	0.21	0.29	0.24	**k_{20}**	12
TP_{out} =	0.18	0.44	0.15	0.20	0.16	**C***	0
TP_{rem} =	0.08	0.20	0.07	0.09	0.07	**θ**	1.00
TP_{rem} (%) =	31.0	31.2	31.2	31.2	31.2	**k**	12

APPENDIX C

BENCH SCALE TREATABILITY STUDY DATA

Lamb Island Dairy Chemical testing September 25-26, 2002

For testing of SRP used Hach Spectrophotometer and diluted 1ml sample in 100 ml DI Water.

Pond 1 Testing Results:

200ml pond 1 water

µl of Alum	P (mg/L
Raw - 0	0.21
60	0.03
100	0.08
150	0.04
200	0.07
250	0.05
300	0
60 - repeat	0.03

Observations:

60 µl – slight color change, little settling
100 µl – floc throughout with tea color, slight settling
150 µl – floc throughout, good settling, yellowish color
200 µl – better settling weak tea color
250 µl – Excellent settling weaker tea color, some suspended floc
300 µl – Water clear total settling

Re-run of pond 1 water sampling at 30, 60 and 100 µl of alum:

µl of Alum	pH	P (mg/L
30	7.09	0.26
60	6.44	0.07
100	6.82	0.14

Observations:

60 µl – Better settling at 60 µl almost clear
100 – floc throughout with yellow color

Pond 1 Sludge:

50g of sludge was mixed with 200 ml water. Each mixture was then mixed with a volume of alum below and allowed to settle for 45 minutes:

µl alum	pH	P (mg/L
Raw sludge - 0	6.98	0.14
100	5.84	0.03
150	5.29	0.02
200	4.82	0.05
250	4.61	0
300	4.43	0
55		0.02

Pond 2 Water:
200 ml of pond 2 water was mixed with a volume of alum below and allowed to settle:

µl alum	pH	P (mg/L
Raw – 0	8.15	0.10
30	7.51	0.01
60	7.19	0.02
100	7.09	0.02
150	6.87	0
200	6.55	0.02
250	6.42	0.03
60 – repeat		0.02

Observations:

30 µl – cloudy floc throughout slight settling
60 µl – Larger particulate floc throughout, slight settling
100 µl – very similar to 60, better clarity
150 µl – clear top 2/3rds defined floc, visible settling
200 µl – water clear, more settling
250 µl – Larger, more floc on bottom

Pond 2 Sludge:
50 g of sludge was mixed with 200 ml of water. Various volumes of alum shown below were mixed with each mixture of sludge.

µl of alum	pH	P (mg/L
Raw – 0	7.86	0.21
100	6.85	0
150	6.5	0

Observations:

100 µl – good settling, still cloudy
150 µl – 250 µl – clear water total settling

Results for treated sludge amended to soil

50 g of sludge treated with 250µl of alum was amended to 250g of soil
Results:

	P (mg/L)
	0.09

100g sludge treated with 250µ of alum was amended to 500g soil and mixed with 400 ml of DI water. Results:

	P (mg/L)
	0.13

50g of sludge treated with 55µ of alum was amended to 250g of soil:

	P(mg/L)
	0.14

Raw Soil Analysis:

10 g of soil was mixed with 100ml of DI water

P - .02 mg/L
P2O5 - .04 mg/L
PO4 - .05 mg/L

250g of soil was mixed with 200 g of DI water and allowed to filter through a Whatman 25 filter for a few minutes and overnight. Results:

	P (mg/L)
Immediate sample	0.08
Overnight sample	0.18

HCA Amended soil Analysis:

250 g of soil was amended with various amounts of HCA(High Clay Aluminum) and mixed with 100 ml DI water. Results:

Grams of HCA	P (mg/L)
2	0.11
4	0.04
8	0.07
16	0.22

Alum Amended soil Analysis:

250 grams soil was amended with various amounts of alum below and mixed with 100 ml of DI water. Results:

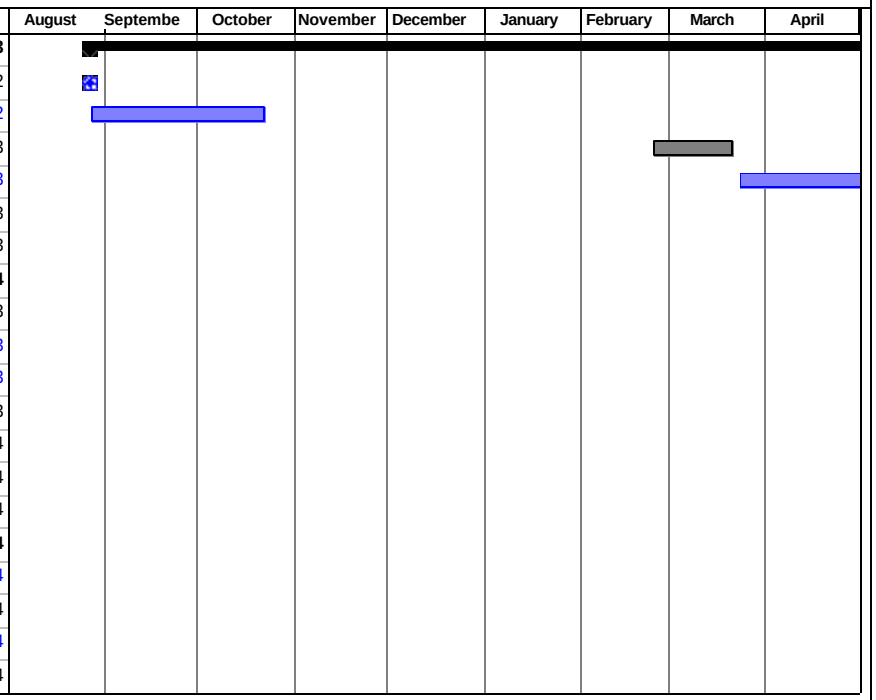
µl Alum added	P (mg/L)
60	0.05
150	0.13
250	0.13

APPENDIX D

PROJECT COMPLETION SCHEDULE

SFWMD RFP NO. C-13410 Lamb Island Dairy Remediation
Project Completion Schedule

ID	Task Name	Duration	Start	Finish
1	**Detailed Design for Selected Alternatives**	**280 days**	**Tue 08/27/02**	**Mon 09/22/03**
2	1.1 Project kick-off meeting	1 day	Tue 08/27/02	Tue 08/27/02
3	1.2 Draft Preliminary 30% Design Package	8 wks	Wed 08/28/02	Tue 10/22/02
4	1.3 Final Preliminary Design Package	4 wks	Mon 02/24/03	Fri 03/21/03
5	1.4 Detailed 90% Design Package	8.2 wks	Mon 03/24/03	Mon 05/19/03
6	1.5 Final Detailed Design & Specification Package	6 wks	Tue 05/20/03	Mon 06/30/03
7	1.6 Construction Deliverables	12 wks	Tue 07/01/03	Mon 09/22/03
8	**Project Implementation & Performance Monitoring**	**300 days**	**Tue 07/01/03**	**Mon 08/23/04**
9	Site Construction	8 wks	Tue 07/01/03	Mon 08/25/03
10	2.1 Draft Performance Monitoring Plan	2 wks	Tue 07/01/03	Mon 07/14/03
11	2.1 Draft Performance Monitoring Plan - review period	4 wks	Tue 07/15/03	Mon 08/11/03
12	2.2 Final Performance Monitoring Plan	2 wks	Tue 08/12/03	Mon 08/25/03
13	Performance Monitoring	52 wks	Tue 08/26/03	Mon 08/23/04
14	2.3 Quarterly Reports	241 days	Mon 07/07/03	Mon 06/07/04
20	2.4 Quarterly Site Meetings	241 days	Fri 07/04/03	Fri 06/04/04
26	**Project Performance Evaluation**	**41 days**	**Mon 07/26/04**	**Mon 09/20/04**
27	3.1 Draft O&M Manual	4 wks	Mon 07/26/04	Fri 08/20/04
28	3.2 Final O&M Manual	4 wks	Mon 08/23/04	Fri 09/17/04
29	3.3 Draft Final Report	4 wks	Tue 07/27/04	Mon 08/23/04
30	3.4 Final Project Report	4 wks	Tue 08/24/04	Mon 09/20/04



Tasks in BLUE will receive Interagency Team review and comment.

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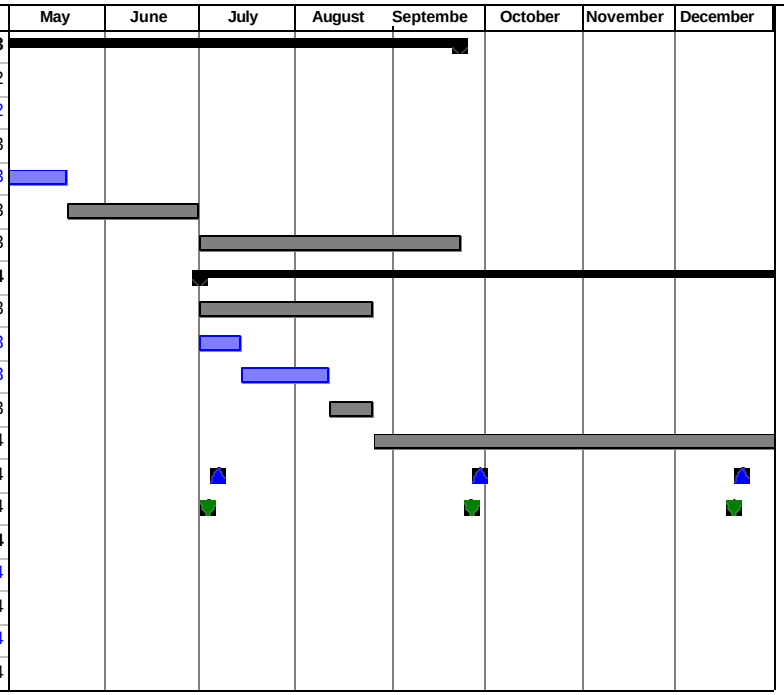
29	3.3 Draft Final Report	4 wks	Tue 07/27/04	Mon 08/23/04
30	3.4 Final Project Report	4 wks	Tue 08/24/04	Mon 09/20/04



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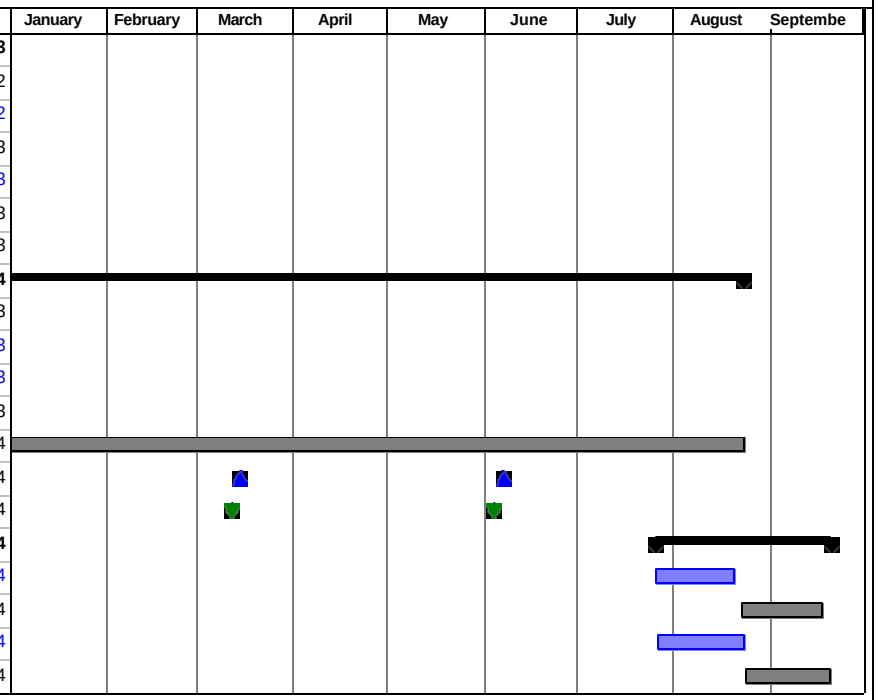
6	1.5 Final Detailed Design & Specification Package	6 wks	Tue 05/20/03	Mon 06/30/03
7	1.6 Construction Deliverables	12 wks	Tue 07/01/03	Mon 09/22/03
8	**Project Implementation & Performance Monitoring**	**300 days**	**Tue 07/01/03**	**Mon 08/23/04**
9	Site Construction	8 wks	Tue 07/01/03	Mon 08/25/03
10	2.1 Draft Performance Monitoring Plan	2 wks	Tue 07/01/03	Mon 07/14/03
11	2.1 Draft Performance Monitoring Plan - review period	4 wks	Tue 07/15/03	Mon 08/11/03
12	2.2 Final Performance Monitoring Plan	2 wks	Tue 08/12/03	Mon 08/25/03
13	Performance Monitoring	52 wks	Tue 08/26/03	Mon 08/23/04
14	2.3 Quarterly Reports	241 days	Mon 07/07/03	Mon 06/07/04
20	2.4 Quarterly Site Meetings	241 days	Fri 07/04/03	Fri 06/04/04
26	**Project Performance Evaluation**	**41 days**	**Mon 07/26/04**	**Mon 09/20/04**
27	3.1 Draft O&M Manual	4 wks	Mon 07/26/04	Fri 08/20/04
28	3.2 Final O&M Manual	4 wks	Mon 08/23/04	Fri 09/17/04
29	3.3 Draft Final Report	4 wks	Tue 07/27/04	Mon 08/23/04
30	3.4 Final Project Report	4 wks	Tue 08/24/04	Mon 09/20/04



Tasks in BLUE will receive Interagency Team review and comment.